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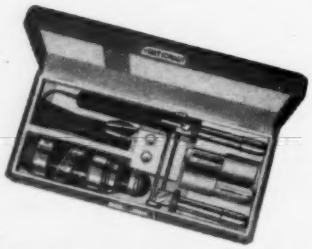

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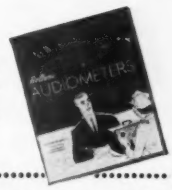
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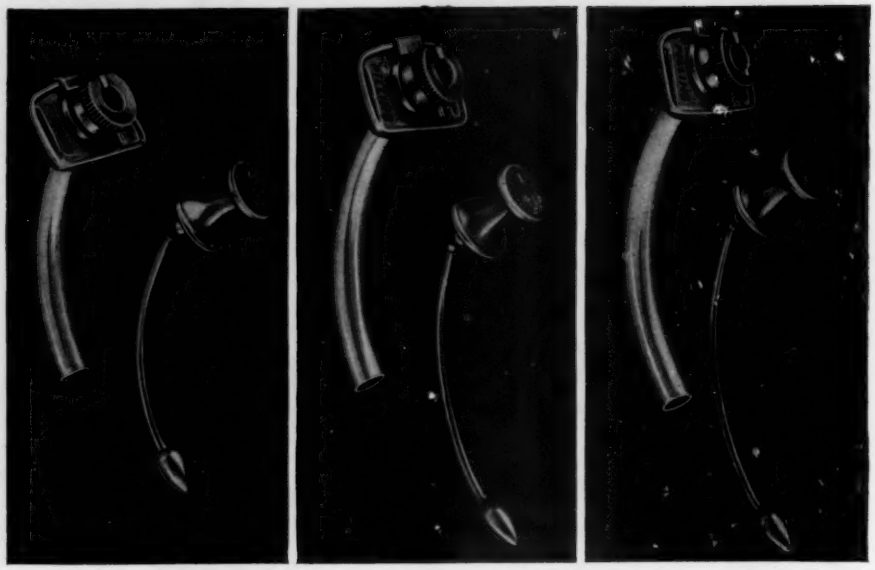

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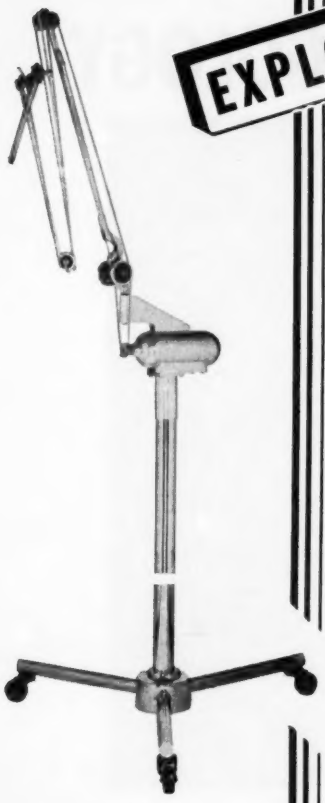

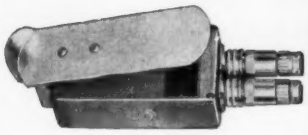

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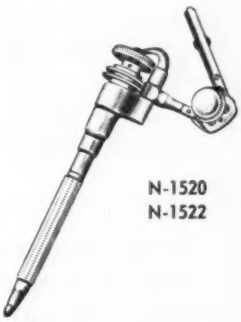

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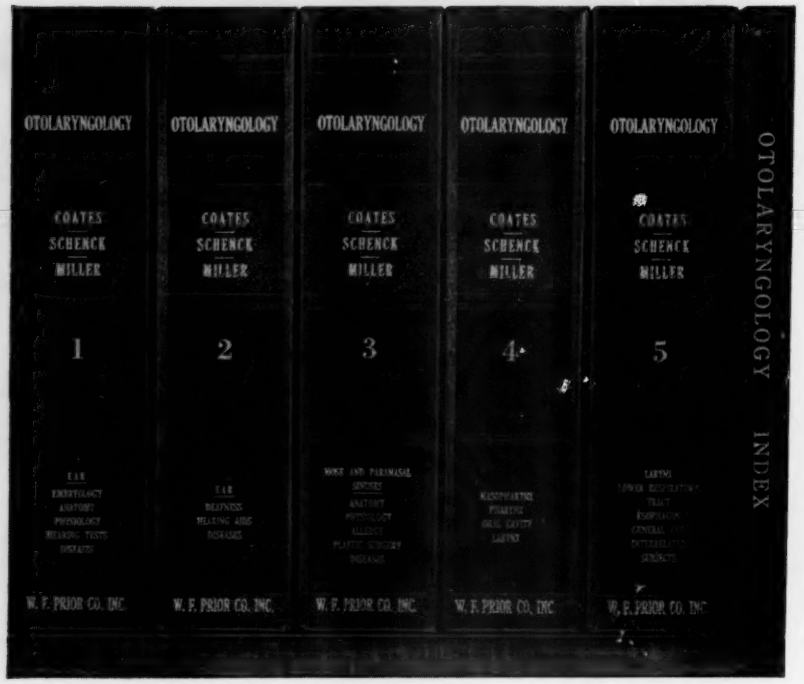

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Despite the efforts of Jackson * and others to prevent the terrible effects of caustic burns in the food passages, each year adds a new crop of unfortunate victims. Even with laws making it compulsory to placard containers of poisons and dissemination of information to the public, the compounds containing lye are ingested accidentally. However, for some reason these chemicals also appeal to the potential suicides. In many instances, the would-be *felo-de-se* is merely interested in obtaining sympathy and uses some familiar caustic poison because it is a handy household article. Too late, after the painful esophagitis, gastritis, and stricture have occurred, he awakens to the fact that he is a lifelong intestinal cripple.

Most of the would-be suicides take only enough lye or other caustic to cause painful intestinal lesions and residual scarring. Occasionally, enough lye is taken to produce overwhelming toxemia and death. In the cases which come to the autopsy early, the usual picture is one of severe, extensive burns of the portions of the intestinal tract contacted by the corrosive.† If the patient survives, the usual end-result is stenosis of the affected portion of the intestine.‡

Jackson [1] states that the esophageal mucosa is very likely to be burned by ingested irritants and that occasionally the lips, tongue, mouth, and pharynx will be normal with burns of the esophagus. This fact is attributed to the greater delicacy of the esophageal mucosa. The extent and depth of the injury to the esophageal mucosa are proportional to the type and concentration of the ingested substance, the amount of the mucosa exposed, and the duration of the exposure. Quite frequently the ingested caustic is vomited back through the esophagus, giving a double exposure to the chemical with the resultant greater chance of damage to the mucosa.

The effect of caustics, such as concentrated sodium hydroxide, upon the mucosal surface is largely a dehydrating one combined with the cytotoxic effect of the strong alkaline substance. The gross and histological pictures are those of overwhelming destruction of the mucosa and submucosa, which slough away with eventual tissue granulation, fibrosis, and stricture formation.§ Similar changes are seen in all areas contacted by the caustic. The gastric mucosa, by virtue of the normal acid-secreting property with

Received for publication Aug. 11, 1955.

Attending Staff Members (Drs. Gregg and Olson); Attending Staff Member and Pathologist (Dr. Mitchell), Sioux Valley Hospital.

* References 1 and 2.

† References 3, 4, 5, 6, 7, 8, 9, and 10.

‡ References 11, 12, 13, and 14.

§ References 15 and 16.

Fig. 1.—Photograph of patient, showing extensive burns within the oral cavity and lips and burns on the face.

the neutralizing effect on alkaline substances, is often damaged to less degree than the epithelium of the upper food passage. However, if a highly concentrated solution is ingested or if the volume is large, the gastric acidity is quickly neutralized and the stomach is often damaged. In the case of strong acids the injury is often more pronounced in the stomach and upper small bowel owing to the excessive acid.[17] In these cases there may be minimal or no damage to the esophageal mucosa. Pascual y Megias [18] reported pyloric stenosis which was demonstrated by x-ray in a patient who drank concentrated sulfuric acid. No esophageal injury was seen. In the discussion on Ganem's [19] paper, Meillere reported a similar case which was seen on x-ray.

Minne and Malaquin [20] reported the radiological findings in a 7-year-old child who took lye by mouth. There was pyloric stenosis without evidence of an esophageal lesion. Moatti and associates [21] also discussed the radiological findings in two patients in whom there was pyloric stenosis without evidence of esophageal injury. Ganem [19] observed a patient who swallowed lye and survived. X-rays of Ganem's patient showed pyloric stenosis but no esophageal lesion. The pyloric obstruction in this case was treated surgically with good result. Gradman and collaborators [22] also reported pyloric obstruction following ingestion of lye without radiological indication of involvement of the esophagus. Boikan and Singer [17] stated that they observed a patient who

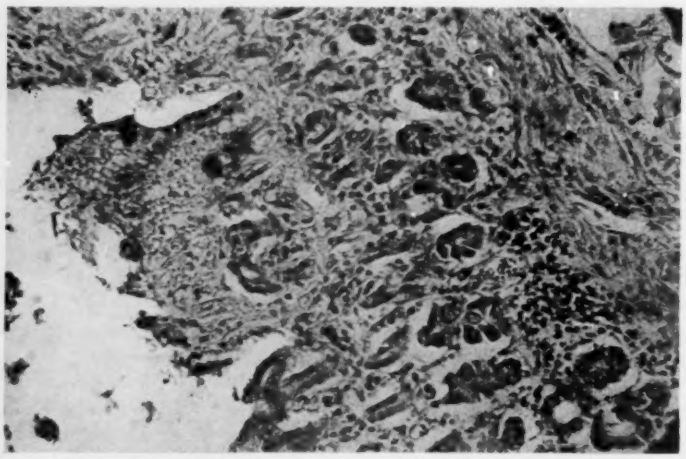

Fig. 2. — Photomicrograph of gastric mucosa from the cardiac area, showing extensive destruction of the glandular elements. The superficial portion of the mucosa is completely necrotic. Some recognizable glandular tissue remains in the deeper areas of the epithelium.

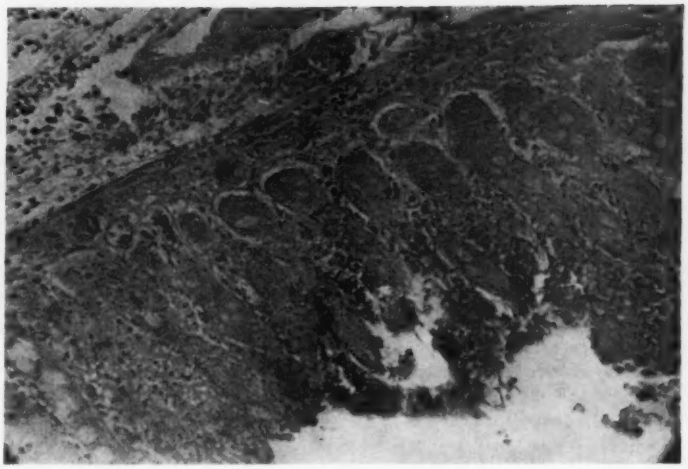

Fig. 3.—Ghost glands of the gastric mucosa in a section from the pyloric region of the stomach. The epithelial elements are completely necrotic and undergoing degeneration.

attempted suicide with lye but survived. Eleven days later he again attempted suicide by another means, this time successfully. At necropsy gastric lesions were observed but no esophageal injury was found. Other authors have reported gastric, duodenal, and jejunal sequalae caused by caustics, along with esophageal injury.‖

In a review of the literature pertaining to the subject of corrosive injury to the food passages, we were unable to find any report of the necropsy findings in a case which came to postmortem examination within five days of the ingestion of lye and which showed no injury to the esophageal mucosa. The case presented here showed paradoxical findings in regard to location, extent, and severity of chemical burns in the upper intestinal tract after ingestion of lye. The unusual necropsy findings are considered worth documentation.

‖ References *23*, *24*, *25*, *26*, and *27*.

REPORT OF A CASE

A 37-year-old housewife was admitted to the hospital after ingesting an undetermined quantity of Drano (a sodium hypochlorite preparation) one hour previously in an admitted suicidal attempt. The vehicle used to carry the lye was not determined, but informants thought it possibly was milk. They reported that she vomited a large volume of fluid after ingesting the poison. She had been in good health but was despondent because of "family trouble." There were superficial burns on the face

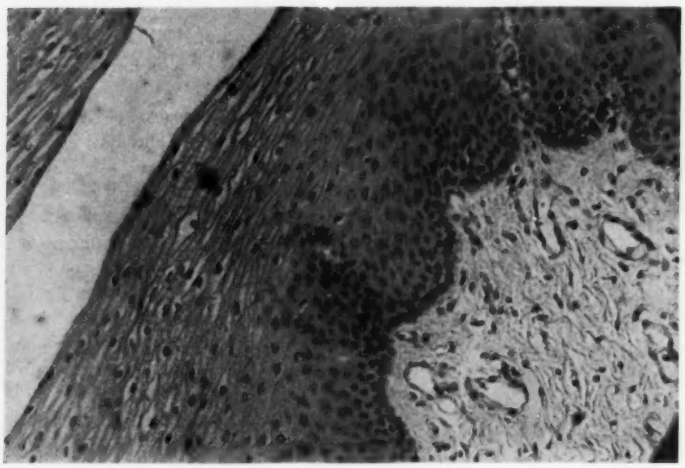

Fig. 4. — Photomicrograph of the mucosa from the midportion of the esophagus, showing normal epithelium and subepithelial stroma.

and lips and extensive burns on the buccal mucosa, tongue, pharynx, and hypopharynx. Because of extensive laryngeal edema, a tracheotomy was done. The patient was treated for shock, pain, and infection and seemed to improve. Twenty-four hours after admission, upper abdominal pain, tenderness, and slight muscle rigidity were noted. The patient became overwhelmingly toxic and died 36 hours after admission.

At necropsy third-degree burns of the oral cavity, pharynx, and larynx were observed. There was extensive destruction of the gastric mucosa, the majority of it being sloughed away. Multiple various-sized perforations of the stomach were found along the greater and lesser curvatures, which were walled off by the liver and the omentum. An extensive hemorrhage was found in the stomach. The remainder of the small and large bowels was normal. The most unusual findings were in the esophagus. From the cricopharyngeal area to the cardiac area, there was no evidence of destruction of the mucosa.

The lack of destruction in the esophagus was difficult to explain after observing the extent of the destruction above and below the esophagus, especially since the patient had ingested and then vomited the irritating solution. Several reasons for the lack of destruction in the esophagus were advanced, but none completely explained the paradoxical picture. The hypothetical explanations which seem to be the most plausible are the following: 1. The short duration of contact by the caustic solution prevented destruction. This hypothesis was refuted by the fact that the patient had vomited the solution almost immediately after swallowing it, yet there was enough contact to burn the mouth and stomach extensively. 2. An unusually patent cardiac sphincter allowing rapid passage into and from the stomach was postulated. 3. Milk may have been the vehicle used to dissolve the caustic. If so, at least some buffering effect could have been present. 4. It is possible that a "mucous blanket" coated the esophagus, protecting the epithelium. 5. Neutralization of the alkali in the stomach by the gastric acid may have helped prevent burns when the solution was vomited. The absence of injury to the esophagus is not adequately explained by any of these factors individually. Undoubtedly, the intact esophageal mucosa was due to a combination of protecting influences.

The ultimate cause of death was overwhelming toxemia due to destruction of the gastric and buccopharyngeal mucosa, complicated by intraintestinal hemorrhage and multiple perforations of the stomach with subsequent localized peritonitis.

CONCLUSIONS

The usual clinical and pathological picture seen in patients who have ingested caustic substances is one of variable but usually extensive destruction of the mucosa of the intestinal tract wherever the ingestant contacts the mucosa. The esophagus, by virtue of its location and because of the sensitive mucosa, is especially susceptible to injury by ingested irritants. In the case presented, the esophagus was skipped by the effect of the caustic substance, while the buccopharyngeal mucosa and the stomach lining were extensively destroyed. Theoretically, the esophagus should have been badly burned, even if only because of its position between the mouth and the stomach. Several reasons for this unusual finding are advanced. We have been unable to find any documented evidence to date of a similar case in which the patient came to necropsy within 36 hours of swallowing lye and showed no evidence of esophageal lesion.

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Some Notes on the Practical Value of the Caloric Test in Clinical Practice

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Although the clinical value of the caloric test has long been recognized, nevertheless, its originator, R. Bárány, appears to have made little effort to work out its quantitative basis, and until recently it has been used in a very rough and ready manner. Thus, Logan Turner's textbook (1952) recommends for the cold caloric test the use of water at 65 F and for the hot caloric test water at 112 to 115 F. Kerrison (1930) suggests the use of water at 86 F run into the ear for 40 seconds. Both authors describe the test with the patient seated in a chair. The generally accepted modification of these tests, as carried out in many clinics, entails syringing the ear with ice-cold water or cold tap water (20 C approximately). Absence of response to this stimulus is taken to denote a dead labyrinth, and no attempt is made to use less violent stimuli for the purpose of evaluating lower degrees of sensitivity loss.

Kobrak (1920) described the minimal stimulation technique, which for many years has been used by him and others for the quantitative assessment of the caloric responses. The disadvantage of this latter procedure is that it involves prolonged examination of nystagmic reactions at or near the threshold of response. For this reason, the tests are both tedious and to some extent inherently inaccurate.

In 1942 a different method of testing was described by Fitzgerald and Hallpike, and it is the purpose of this paper to review our experience with it in the light of 10 years' regular use in several hospital clinics, amounting in all to some two to three thousand tests.

The test procedure was designed to be easy to carry out and comfortable for the patient. The stimulus strengths were selected as being well above the threshold for the normal subject and yet unlikely to involve any of the labyrinthine sense organs other than those of the external canal. Both cold and hot stimuli were used, at temperatures 30 and 44 C, equidistant from body temperature and thus calculated to produce equal and opposite cupular deflections. Comparisons of the durations of the resultant nystagmus could be made with those obtained in normal subjects, thus giving a measure of the sensitivity of the canal sense organs as well as revealing any irregularity between the left and right canals. In addition, the use of both cold and hot stimuli made it possible to demonstrate directional preponderance of the responses, a phenomenon of considerable clinical importance, to which further reference will be made. The general arrangements for the test are shown in Figure 1.

METHOD

The patient lies comfortably on a couch with his head raised 30 degrees from the horizontal, and fixes his gaze upon a mark upon the ceiling or elsewhere in the straight-ahead line of vision. In order to avoid fatigue the patient need in many cases only be asked to concentrate on the mark during the final 30 seconds or so of the test.

Elaborate methods of preparing the irrigating water are unnecessary and often inaccurate. A 2-pt. metal douche can is used, and the water obtained from separate hot and cold water taps. The thermometer used reads 20 to 50 C in 0.1 degree steps. It is approximately 12 in. long and is mounted upon

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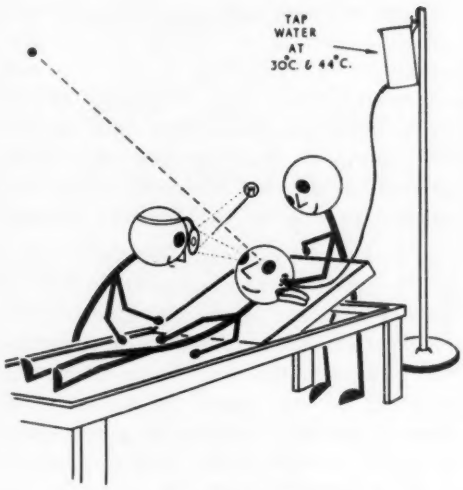
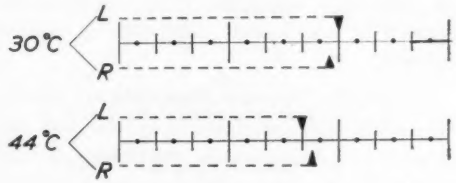


Fig. 1.—Set-up for caloric test.

a perforated wooden plunger which is used for mixing. With practice and care the correct water temperature is obtainable in under half a minute. The douche can should be suspended at a constant point above the patient's head to give approximately a 2-ft. head of water. A rubber tube leads the water through a nozzle which will deliver about 15 to 20 oz. during the 40 seconds' stimulus time. It is important to run off fluid from the tube immediately before commencing the test in order to obtain a constant irrigating temperature, and a minimum of time should elapse between the completion of the preparation of the water and the commencement of the irrigation. The fluid used for each irrigation should be measured in order to check the constancy of flow, a point of some importance which is also dependent on the use of a routine method of holding the nozzle in the meatus. Good illumination is important for observation of the nystagmus, but no other aid to the viewing is of real value. Care is taken not to impede the patient's line of fixation during the later stages of the test. The time from the onset of the stimulus to the end of the nystagmus is measured and normally is found to average some 2 minutes. Nausea or other symptoms are unusual, and the temperatures of 30 and 44 C are not unpleasant for the patient. A stop watch, although not essential, greatly facilitates the test. Attention is given principally to the measurement of the duration of the nystagmus, but a general impression of its briskness is often useful, as a small time difference between responses may be significant only if associated with a difference in the briskness.



NORMAL.

Fig. 2.—Caloric-test pattern of an average normal subject.

RECORDING OF RESULTS

The results are charted in the form shown in Figure 2. Each of the continuous lines represents a 3-minute period, subdivided into intervals of 10 seconds. Above are shown left and right (L and R) responses to the cold stimulus. Responses to the hot stimulus are shown below. The response durations

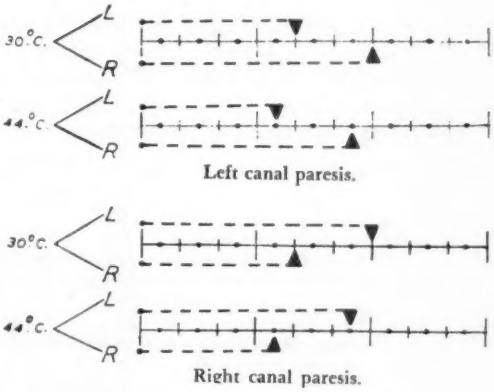


Fig. 3.—Caloric-test pattern characteristic of unilateral loss of canal sensitivity.

are indicated by the interrupted lines. It will be noted that the response duration is taken as the time period between the application of the stimulus and the end of the visible nystagmus. No attempt is made to measure the latent period of the nystagmus. The responses shown in Figure 2 are representative of an average normal subject. The duration of the cold responses is 2 minutes and of the hot responses somewhat less, 1 minute 40 seconds. It is convenient for reference to number the above responses 1 to 4, from above downward. It should be noted that the responses 1 and 4 consist of nystagmus to the R. Responses 2 and 3 consist of nystagmus to the L.

From this normal pattern, two principal types of deviation occur: 1. Loss of sensitivity of one or the other external canal, a so-called canal paresis. This is shown in Figure 3. The loss of sensitivity may be of any degree up to a complete absence of response, and bilateral losses may, of course, also occur. 2. Directional preponderance. Here the responses which consist of nystagmus in a particular direction are enhanced, while those in the opposite direction are inhibited. The caloric-test patterns characteristic of directional preponderance to the R and L are shown in Figure 4.

DIRECTIONAL PREPONDERANCE TO RIGHT.

DIRECTIONAL PREPONDERANCE TO LEFT.

Fig. 4.—Caloric-test pattern characteristic of directional preponderance.

The clinical importance of directional preponderance of the caloric responses is now recognized to be considerable, since it occurs in association with a wide variety of lesions of the vestibular apparatus and its central connections. Thus, Fitzgerald and Hallpike (1942) were able to show that lesions of the temporal lobes were constantly associated with directional preponderance of the caloric responses to the side of the lesions.

This finding has now been confirmed and extended by Carmichael, Dix, and Hallpike (1954) as the result of observations carried out upon an extensive series of subjects with unilateral cerebral lesions. Directional preponderance of the caloric responses is also encountered as a result of lesions of the labyrinth, the vestibular nerve, and its central connections, and its association with labyrinthine lesions is of special clinical importance in relation to Ménière's disease.

In their paper of 1942, Cawthorne, Fitzgerald, and Hallpike stated that in 20% of cases of unilateral Ménière's disease directional preponderance of the caloric responses was present to the side of the unaffected labyrinth. In this paper the authors also advanced the suggestion that the phenomenon is due to damage of the otolith apparatus of the affected labyrinth, in particular the utricle. Thus, with cases of unilateral labyrinthine disease, the phenomenon of directional preponderance to the opposite side of the caloric responses would appear to be indicative of a utricular lesion.

COMBINATION OF CANAL PARESIS AND DIRECTIONAL PREPONDERANCE

Although it is usual in Ménière's disease to encounter canal paresis or directional preponderance alone, they may, as described by Cawthorne, Fitzgerald, and Hallpike (1942), occur in combination. The effect of this upon the pattern of the caloric responses is demonstrated in Figure 5. Here is shown above the patterns of a left canal paresis (*A*) and a directional preponderance to the right (*B*), the latter being attributed to a lesion of the left utricle.

The canal paresis is introduced into the pattern of the directional preponderance by a process of algebraic summation, as shown by the open triangles, and the resultant pattern of the caloric responses is shown below.

In this, the two cold responses are identical, with wide separation of the hot responses. A comparable variation of the pattern is obtained with a similar combination of lesions of the right labyrinth. Again, in bilateral lesions, crossed combinations may occur.

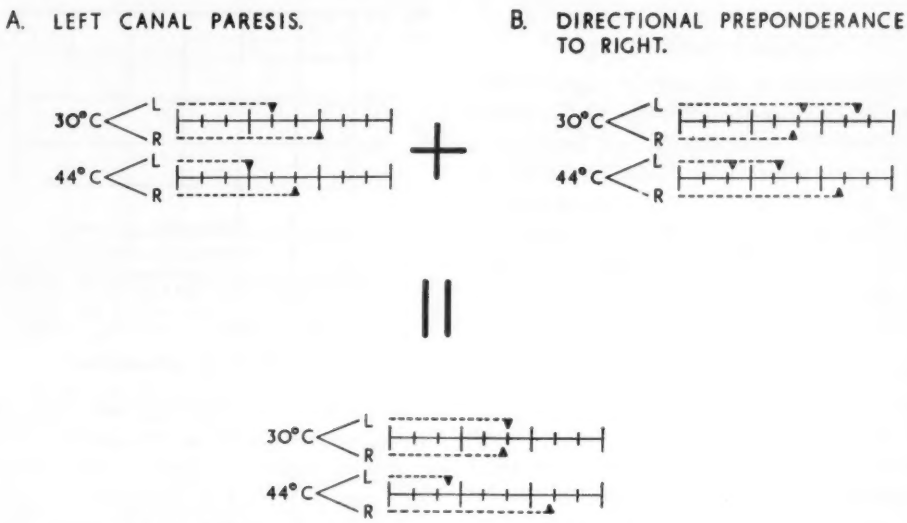


Fig. 5.—Effect of Ménière's disease upon the pattern of caloric responses.

In all of these conditions the pattern of the caloric responses varies in a manner which may be extremely confusing, but is, nevertheless, nearly always capable of interpretation in accordance with the principles outlined above. The full range of possibilities was described in detail by Hallpike, Harrison, and Slater, and the composite diagram shown in Figure 6 is reproduced from their paper.

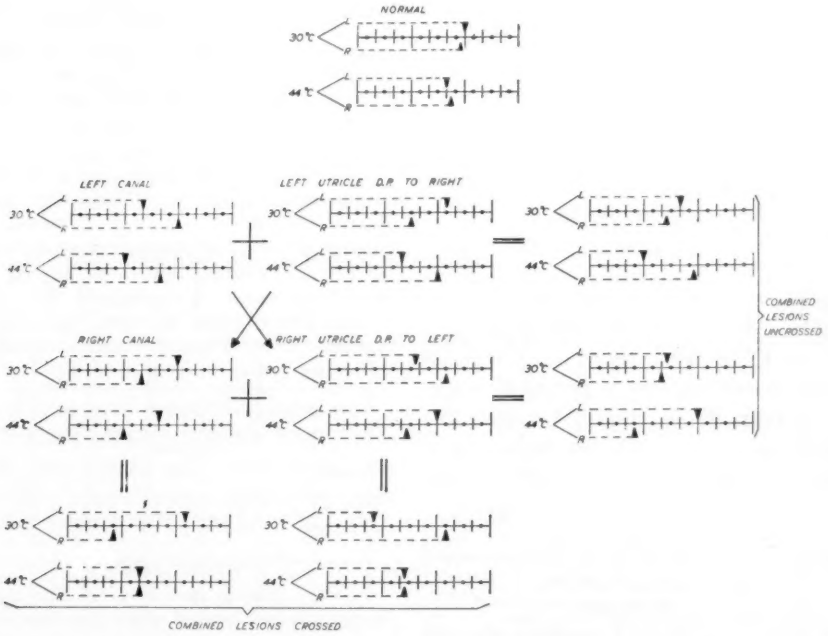


Fig. 6.—Full range of possibilities of caloric responses. (Reproduced by permission from Hallpike, C. S.; Harrison, M. S., and Slater, E.: *Acta oto-laryngologica*, Väpnargatan 6, Stockholm.)

STATISTICAL BASIS OF THE CALORIC-TEST RESULTS

The results of the caloric tests, carried out according to the technique of Fitzgerald and Hallpike, were studied in a large series of normal subjects by Hallpike, Harrison, and Slater. Their findings were published in 1951 in the *Acta oto-laryngologica,* to which reference should be made. In respect to both canal paresis and directional preponderance the distribution curves were shown to have normal Gaussian characteristics with mean values of 0, and standard deviations, having the reasonably low value in each case of 15 seconds. These results have been confirmed by similar statistical analyses carried out by Petermann (1953), of Zurich, and by Thomsen (1953), of Copenhagen, and the data in general provide a very satisfactory basis for the interpretation of the caloric-test findings in abnormal subjects.

PRESENT INVESTIGATION

Investigations have been carried out on 225 characteristic cases of Ménière's disease. The results of the caloric tests are summarized as follows:

Unilateral abnormalities		83%
Canal paresis	50%	
Directional preponderance to the unaffected side	20%	
Combined lesions	13%	
Bilateral abnormalities		12%
Variations of test results on repetition		4%
Normal responses		1%
		100%

A point of importance has been the remarkable constancy of the test results obtained with repeated tests on particular subjects carried out over a period of years. Thus, a canal paresis would generally remain constant or increase in degree. In a number of instances, however, the patterns

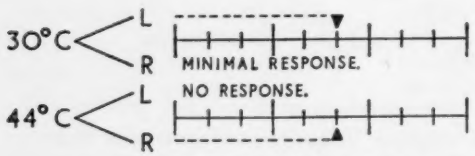


Fig. 7 (Case 1).—Caloric-test results.

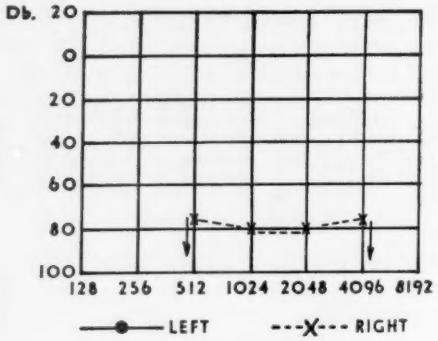


Fig. 8 (Case 1).—Audiogram.

of the caloric tests have been found to vary throughout the course of the disease. Thus, on one occasion directional preponderance alone may be present to the unaffected side; on another, canal paresis. On other occasions the two are found in combination. Nevertheless, the test results, when interpreted in accordance with the principle outlined above, have continued throughout to indicate a lesion of the affected labyrinth.

The following illustrative cases are appended.

REPORT OF CASES

Directional Preponderance

Case 1.—Patient, aged 21 years, first seen September, 1948, with a history of deafness since birth. When seen again, January, 1949, patient had had two attacks of vertigo monthly since 1948, associated with vomiting. No tinnitus.

On examination: Ears, nose, and throat healthy.

Audiogram and caloric-test results are given in Figures 7 and 8.

Response to medical treatment unsatisfactory during 1949. Condition likely to be related to left labyrinthine defect. Recommended left labyrinthotomy. Left labyrinth destroped September, 1950. December, 1950: Patient's condition satisfactory. No further vertiginous attacks.

Comment.—Vertigo is here seen in a patient with a severe congenital bilateral labyrinthine disorder. The caloric tests demonstrate directional preponderance to the right, indicative of a lesion of the left labyrinth.

Canal Paresis

Case 2.—Patient, aged 50 years, first seen Dec. 14, 1949, complaining of attacks of rotational vertigo with a ringing tinnitus in the right ear of six months' duration, but much worse during the last three months.

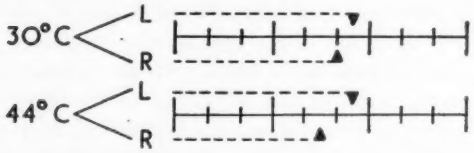


Fig. 9 (Case 2).—Caloric-test results.

On examination: Nose and throat healthy. Both tympanic membranes healthy. No spontaneous or positional nystagmus. Steady with Romberg's test.

Audiogram and caloric-test results are shown in Figures 9 and 10.

As patient was unable to have medical treatment, a right labyrinthotomy was recommended and was undertaken at once. March 15, 1950: Condition satisfactory. No further vertiginous attacks.

Comment.—In spite of an almost complete deafness of the right ear, the cold caloric responses showed only a slight abnormality. This abnormality, though small, was constant. It would have been quite impossible to demonstrate it with the usual caloric-test technique using ice-cold water.

Combined Lesions

Case 3.—Patient, aged 43 years, first seen Aug. 10, 1949. For last five months has had attacks of clockwise rotational vertigo with vomiting. Attacks increasing in severity. Two to six attacks weekly of up to three-fourths hour's duration. Varying tinnitus in left ear and deafness, which is worse during the attacks.

On examination: Nose and throat healthy. Tympanic membranes normal, move well with autoinflation. No spontaneous nystagmus. Steady on Romberg's test.

Audiogram and caloric-test results are shown (Figs. 11 and 12).

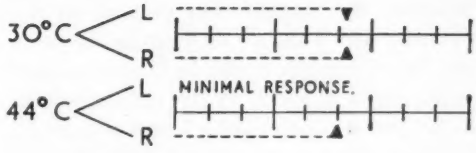


Fig. 11 (Case 3).—Caloric-test results.

Patient failed to respond to medical treatment, including salt and fluid restriction, sedation, histamine, and nicotinic acid. Left labyrinth opened and destroyed. Following this, no further vertiginous attacks.

Comment.—This patient showed a marked left deafness and an abnormality of the caloric-test pattern, indicative of a combination of lesions of the left external canal (canal paresis) and of the left utricle. (Directional preponderance to the right.)

Correlation of Caloric Abnormality with Hearing Loss and Tinnitus

It has been of interest to note that, although unilateral tinnitus and deafness have usually been present in the ear exhibiting a caloric abnormality, thas has by no means always been the case.

Hearing Loss.—In 70% of the cases a unilateral hearing loss was present. In 66% of these a caloric abnormality was present on the side with the hearing loss. In 15%, however, a caloric abnormality was present on the opposite side.

Tinnitus.—Fifty-one per cent of the cases complained of tinnitus localized to the side of the caloric abnormality. In a further 7%,

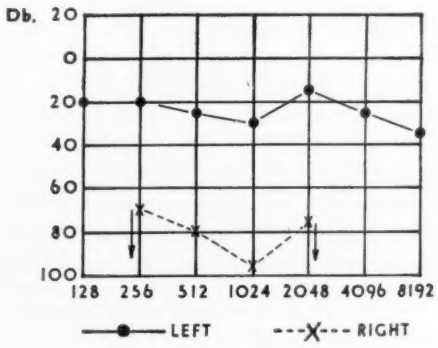


Fig. 10 (Case 2).—Audiogram.

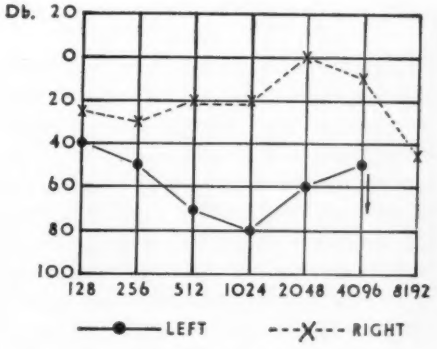


Fig. 12 (Case 3).—Audiogram.

however, the tinnitus was present on the opposite side. Thus the laterality of the hearing loss or tinnitus cannot be taken to denote with certainty which of the two labyrinths is the site of the vestibular lesion responsible for the vertigo.

COMMENT

Although the results obtained leave little doubt of the practical advantages of the Hallpike caloric-test technique, its disadvantages must also be commented on. Here the greatest drawback has been the time involved. For the full caloric test each patient requires some 15 to 20 minutes. For this, few busy otologists are prepared, and thus the examination is difficult to incorporate in the routine of a busy clinic. In addition, the tests themselves undoubtedly require considerable practice, concentration, and attention to detail.

We have therefore found it necessary to make special arrangements whereby two or three patients requiring caloric tests are set aside and examined in a special room at the end of a clinic or given appointments to be examined at a special session. This greatly increases the efficiency of the examination.

The advantages of the test can be summarized as follows: Firstly, the fact that the caloric stimulus can be confined to a particular sense organ of one labyrinth confers upon the test a localizing value in the diagnosis of vestibular disease, unattainable by any rotational test involving the use of the Bárány chair or its more modern developments. With such procedures both labyrinths are, of course, excited, and hence any deviation from the normal response, short of total abolition, is difficult to interpret in terms of a lesion of one or the other labyrinth. Secondly, the test is practical, comfortable for the patient, and, given the necessary conditions, reasonably easy for the examiner. The test results are repeatable and are nearly always related in a significant and useful way to the rest of the clinical picture. They thus have a diagnostic value unobtainable with any other caloric-test technique. It is, however, necessary to stress that this is only the case if the test results are interpreted according to the theoretical principles outlined by its originators.

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Therapeutic Air Humidification

Its Rationale in Acute Laryngotracheobronchitis in Children

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Acute laryngotracheobronchitis in children is characterized by an abundant secretion of a thick, viscid, sticky material by the mucosa of the tracheobronchial tree. Such abnormal exudate tends to lose its water content to the breathed air, becomes more and more viscid until, finally, crusts are formed on the surface of the mucosa. The bronchial secretions may become sufficiently viscid to obstruct the bronchial tree, and such bronchial obstruction is responsible for obstructive atelectasis and obstructive emphysema, so frequently observed in this condition. Death in acute laryngotracheobronchitis, which still occurs in 20% of cases, is most frequently due to suffocation from bronchial obstruction.

To prevent bronchial obstruction steps must, therefore, be taken to counteract the tendency of the tracheobronchial exudate to become too viscid and eventually crusty and thus facilitate the expulsion of the exudate from the tracheobronchial tree by the cough of the patient. Atmospheric humidification has been used in acute laryngotracheobronchitis for this purpose, and almost all workers are agreed upon the beneficial effect of such therapy. The humidification of the air is usually brought about either by the steam kettle or by the mechanical humidifier. The accepted view, however, is that cold moisture produced by the mechanical humidifier is to be preferred to that from the steam kettle.[1]

The object of this paper is to analyze the physical basis of water vapor therapy in acute laryngotracheobronchitis, to examine whether the accepted view as cited above is valid, and to consider the best way of administering water vapor therapy.

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From the Department of Pediatrics B (Head: Dr. W. Falk), Rambam Government Hospital.

ANALYSIS OF FACTS

1. Physical Considerations

Table 1 shows the absolute values of the water content of the air, in terms of grams per cubic meter, at various temperatures when fully saturated with water vapor.[2]

TABLE 1.—*Water Content of Saturated Air at Various Temperatures*

Temperature, C	Water Content, Gm./Cu.M.	Temperature, C	Water Content, Gm./Cu.M.
0	4.85	19	16.31
1	5.19	20	17.30
2	5.56	21	18.34
3	5.95	22	19.43
4	6.36	23	20.58
5	6.80	24	21.78
6	7.26	25	23.05
7	7.75	26	24.38
8	8.27	27	25.77
9	8.82	28	27.23
10	9.40	29	28.76
11	10.01	30	30.37
12	10.66	31	31.05
13	11.35	32	33.81
14	12.07	33	35.66
15	12.83	34	37.58
16	13.63	35	39.60
17	14.48	36	41.71
18	15.37	37	43.91

These values represent the maximal amounts of water vapor that air at any given temperature can possibly contain. Thus, for example, at 15 C air fully saturated with water vapor will contain 12.83 gm/cu. m. No matter how much water vapor is driven by evaporation into that air, provided the air remains at the same temperature of 15 C, this value of 12.83 cannot be exceeded, and any excess of water vapor will be deposited back on the surrounding surfaces as liquid water.

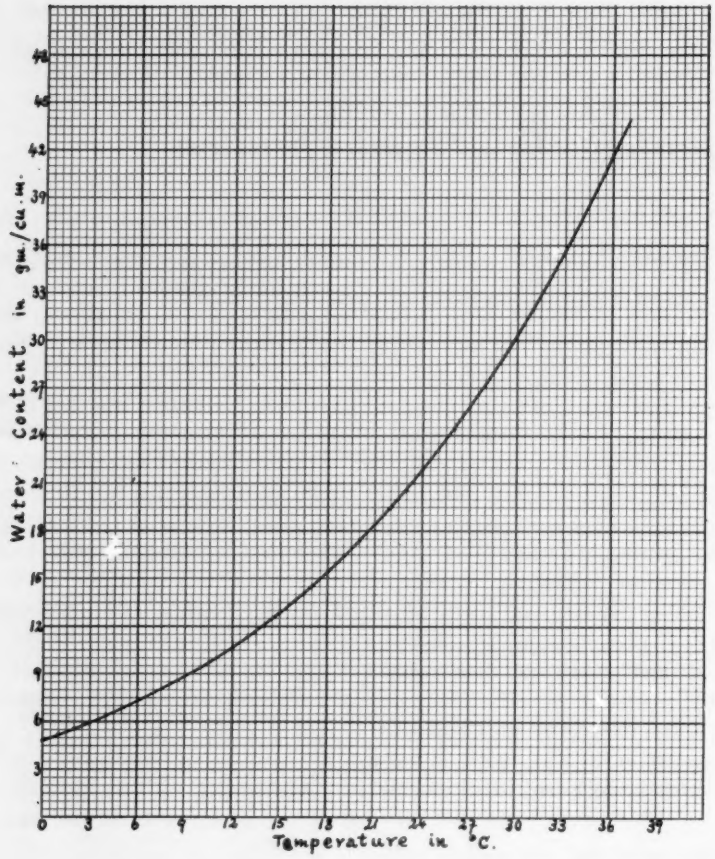

Fig. 1.—Water content of saturated air at various temperatures.

This maximal water vapor content of air is dependent upon the temperature. As is seen in Table 1 and demonstrated in Figure 1, the higher the temperature the higher is the maximal water content of the air. Thus, while air at 15 C when fully saturated contains 12.83 gm/cu.m., air at 25 C when fully saturated contains about 23 gm/cu.m., and at 35 C the air contains about 40 gm/cu.m. provided it is fully saturated.

The surrounding air is, however, rarely if ever fully saturated, and its water content will, of course, be less than the maximum, depending on the relative humidity. Thus if air at 15 C contains 12.8 gm/cu.m. when fully saturated, it will contain only 6.4 gm/cu.m. at a relative humidity of 50%.

Table 2 shows the absolute values in grams per cubic meter of the water content of air at various temperatures and various relative humidities. This is represented diagrammatically in Figure 2. From Table 2 and

TABLE 2.—*Water Content of Air (in Grams per Cubic Meter) at Various Temperatures and Relative Humidities*

Temperature, C	Relative Humidity				
	100%	80%	60%	40%	20%
0.....	4.85	3.88	2.91	1.94	0.97
5.....	6.80	5.44	4.08	2.72	1.36
10.....	9.40	7.52	5.64	3.76	1.88
15.....	12.83	10.26	7.70	5.13	2.57
20.....	17.30	13.84	10.38	6.92	3.46
25.....	23.05	18.44	13.83	9.22	4.61
30.....	30.37	24.30	18.22	12.15	6.07
35.....	39.60	31.68	23.76	15.84	7.92
37.....	43.91	35.13	26.35	17.56	8.78

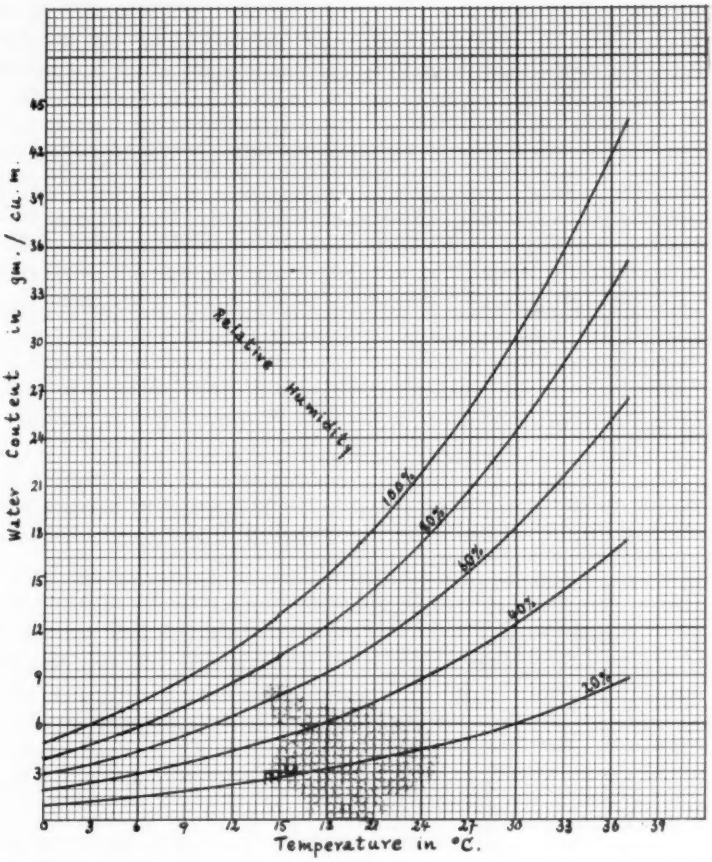

Fig. 2.—Water content of air at various temperatures and relative humidities.

Figure 2 it is clearly evident that the actual water content of air at any given time is determined by two factors: (*a*) the temperature and (*b*) the relative humidity at that time. Thus at 15 C and a relative humidity of 60% air would contain 7.7 gm/cu.m. This actual amount of water vapor in grams per cubic meter that is contained in the air under a certain set of conditions is also termed the "absolute humidity" of the air under those conditions.

Examining Table 2 and Figure 2 it is evident that the same water content in grams per cubic meter may be present in air at a high temperature and low relative humidity as in a low temperature and high relative humidity. For example, air at 10 C and 100% relative humidity contains about the same amount of water vapor as air at 25 C and 40% relative humidity, namely, about 9.3 gm/cu.m. It thus seems clear that raising the relative humidity even to 100% may, by itself, not alter the actual water content of the air at all if at the same time the temperature is being lowered.

2. Physiologic Considerations

In the process of respiration the air enters the respiratory tract at room temperature and humidity. On its way down, the air absorbs moisture from the mucosa of the respiratory passages and ends up at the pulmonary alveoli at body temperature and saturated with water vapor.[3] The air expired is thus constantly at a relative humidity of 100% and at a temperature of 37 C, and,

as seen in Table 2, air under these conditions has a water content of 43.9 gm/cu.m. The differences in temperatures and humidities of the inhaled and exhaled air result in a continuous loss of water from the respiratory tract, and the amount of water lost is obviously dependent entirely on the water content of the air inhaled at room conditions. Thus if the water content (or absolute humidity) of air at room conditions is equal to x gm/cu.m., then for every cubic meter of air inhaled by the patient the respiratory loss is equal to 43.91 minus x gm. of water vapor. As already stated, however, the value of x depends on both the relative humidity and the temperature of the surrounding air.

TABLE 3.—*Water Loss (in Grams per Cubic Meter) by Secretions of Respiratory Tract to Air Breathed at Various Temperatures and Relative Humidities*

Temperature, C	Relative Humidity				
	100%	80%	60%	40%	20%
0.....	39.06	40.03	41.20	41.97	42.94
5.....	37.11	38.47	39.83	41.19	42.55
10.....	34.51	36.39	38.27	40.15	42.03
15.....	31.08	33.65	36.21	38.78	41.34
20.....	26.61	30.07	33.53	36.99	40.45
25.....	20.86	25.47	30.08	34.69	39.30
30.....	13.54	19.61	25.69	31.76	37.84
35.....	4.31	12.23	20.15	28.07	35.99
37.....	0.00	8.78	17.56	26.35	35.13

Table 3 shows the actual amounts of water vapor lost by the respiratory tract to the air breathed at various temperatures and relative humidities. The values recorded represent 43.91 minus x gm/cu.m., where x stands for values obtained in Table 2 of water content in grams per cubic meter of the surrounding air at the various temperatures and relative humidities. Figure 3, which is based on Table 3, shows a series of curves which are lines of equal water loss by the respiratory tract to the air breathed under varying conditions of room air temperatures and relative humidity.

Examining Table 3 it is clearly seen that the amount of water vapor lost by the respiratory tract is as dependent upon the temperature of the surrounding air as upon its relative humidity, since as a matter of fact the loss is determined by the absolute water content (absolute humidity) of the surrounding air, which is a function of both. To quote but one example: The patient is, figuratively speaking, just as badly off at a temperature of 20 C and a relative humidity of 50% as at a temperature of 10 C and a relative humidity of 100%, since, as seen in Table 2, in both cases the absolute humidity is around 9 gm/cu.m., and consequently the amount of water vapor lost by the respiratory tract is the same in both cases, around 35 gm/cu.m., as seen in Table 3. Examining Figure 3 it is seen that the loss of 35 gm/cu.m. of water vapor to the surrounding air occurs in addition to the above room conditions, also at 30 C and 30% relative humidity, at 37 C and 20% relative humidity, and, of course, at the various intermediary conditions.

Examining further Table 3 it is seen that at normal room temperatures even if the air is fully saturated the loss of water vapor in the process of breathing is still very considerable. At a temperature of 15 C the loss amounts to 31.1 gm/cu.m., while at 20 C it amounts to 26.6 gm/cu.m. These figures amount to as much as 71% and 61%, respectively, of the maximum of 43.9 gm/cu.m., which is what the loss would have been had the air been totally devoid of water vapor.

Assuming room conditions to be (as they frequently are) a temperature of 15 C and a relative humidity of 60%, it is seen from Table 3 that the total effect of raising the relative humidity to the saturation point (100%), keeping the temperature constant, is merely to reduce the loss of water vapor by the respiratory tract by about 5 gm/cu.m. of air (from 36 to 31 gm. approximately). On the other hand, by raising the temperature to, say, 25 C and keeping the relative humidity unaltered (namely, 60%), the loss of water vapor is reduced by about 6 gm/cu.m. (from 36 to 30 gm. approximately). However, by doing the two things together, that is, raising the relative humidity to 100% and the temperature to 25 C, the loss of

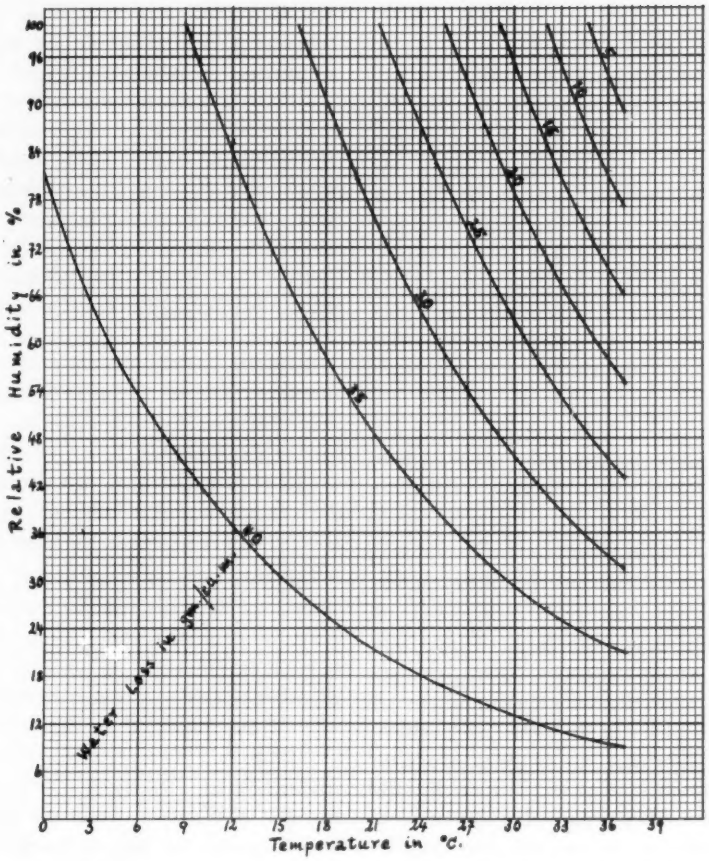

Fig. 3.—Lines of equal water loss by the respiratory tract under various conditions of air temperature and relative humidity.

water vapor is reduced by about 15 gm. (from 36 to 21 gm/cu.m. approximately).

3. Clinical Considerations

Under normal conditions, the water lost by the respiratory tract is one of the ways in which the so-called obligatory loss of water from the human organism takes place. This loss through the respiratory tract is entirely physiologic and is not detrimental in any way, either local or general, to the human body.

The state of affairs is, however, entirely different in case of abnormal conditions in the respiratory tract, such as acute laryngotracheobronchitis. Under such circumstances the loss of water vapor by the pathologic secretions of the respiratory tract causes a gradual and continuous inspissation of the secretions, with eventual crusting and plugging of the air passages. Furthermore, the loss of water vapor by the bronchial secretions in acute laryngotracheobronchitis is considerably greater than under normal conditions. This is due to the fact that, whereas normally the moisture originates mostly in the nasal passages and only partly in the tracheobronchial tree, in acute laryngotracheobronchitis, owing to the frequently accompanying nasal obstruction of inflammatory origin, the air bypassing the nasal passages obtains its moisture entirely from the tracheobronchial tree. Thus the loss of moisture by the tracheobronchial secretions is further increased and therefore more detrimental. This is all the more so in the

presence of a tracheotomy, in which case air even bypasses the oral cavity.

From the foregoing it is clear that the only way to reduce the loss of water vapor by the exudate of the tracheobronchial tree to the surrounding air is by increasing the water content of the surrounding air. It is also clear that increasing the relative humidity even to 100% but leaving the temperature unmodified is, in itself, definitely inadequate to achieve the desired increase in the water content of the air. It can only be done by suitably raising both the relative humidity and the temperature of the air inhaled. To achieve the best results the air inhaled by the patient should ideally have not only a relative humidity as close to 100% as possible but also a temperature as near to 37 C as is compatible with the comfort of the patient.

It must also be realized that measures to reduce the water loss by the bronchial exudate in acute laryngotracheobronchitis are indicated in every case and under any circumstances, with the exception perhaps of tropical atmospheric conditions. At all other "normal" conditions of temperature and humidity the loss of water vapor by the respiratory tract of the patient is so considerable that means to reduce such loss may be actually lifesaving. Needless to say, at relative humidities which are below "normal," as also at lower temperatures, the seriousness of the loss is increased, and the measures to be employed are all the more indicated.

COMMENT

The methods available at the present time of air humidification are two in number. The older method is the "hot steam" method, consisting of heating water in a kettle, croup kettle, or steam vaporizer. The more modern method, however, consists of the mechanical vaporization, in which water vapor is produced without heat. Of these two methods the mechanical humidifier seems to be the preferred method by most authorities.

Thus, Morrison [4] believes that steam vaporizers are contraindicated and advises placing the patient in a room in which the relative humidity is maintained at 95% by means of a Walton humidifier and the temperature is maintained at "not more than 70° F." Nelson [1] also prefers a humidified room in which the atmosphere is saturated with moisture from a mechanical humidifier rather than by steam, since "the old steam room or croup tent too often becomes a desiccating oven, defeating its purpose." Lederer [5] is also of the opinion that "the mechanical humidifier is to be preferred since the room may be kept at a comfortable temperature (70 to 75° F) with a relative humidity of 90% to 95%." Barach [6] states that "the hot air so often obtained in a croup tent is not desirable, since it is the moisture which is probably the therapeutically effective agent in steam inhalation," and therefore also prefers the mechanical humidifier.

All the authors mentioned, and many others, speak of the relative humidity as if it were the deciding, and perhaps only, factor in air humidification. It does not seem to be appreciated that it is not the relative humidity but the absolute humidity of the surrounding air which is of importance in preventing water loss by the respiratory tract and that in order to obtain the highest absolute humidity of the surrounding air the temperature cannot be disregarded and set at a comfortable low of not more than 70 F. I have attempted to show that it is not possible to maintain both a low temperature of 70 F and a high absolute humidity at the same time. It must be realized that a high water content, or absolute humidity, of the surrounding air can be achieved only by having both the relative humidity and the temperature as high as possible. As has already been stated, in order to achieve the best results the air must be saturated with water vapor and must be at a temperature as close to 37 C as feasible.

As to the means of achieving this aim, it seems clear that the mechanical humidifier is, by itself, totally inadequate for the purpose, since the highest water vapor content attainable by it is that of saturation at the room temperature prevailing at the time. The

mechanical humidifier can, of course, be used in conjunction with some heating device designed to raise the temperature of the room at the same time. This, however, would defeat the purpose for which the mechanical humidifier was originally designed, namely, to produce water vapor without heat. Such an objective is obviously unattainable, and the mechanical humidifier came into being on entirely false premises and can on no account be considered an improvement over the older steam method.

Rather than use the mechanical humidifier in conjunction with a heating device, I am of the opinion that the good old steam kettle or steam room is to be preferred. Needless to say, all the necessary precautions must be taken against the hazard of a burn, as well as against the tendency to produce hyperpyrexia in the child, by means of adequate hydration and the proper and judicious use of ice.

SUMMARY

The rationale of water vapor therapy in acute laryngotracheobronchitis is discussed. It is pointed out that the loss of moisture from the air passages is dependent upon the absolute humidity of the air breathed and not upon its relative humidity. To reduce the loss of water from the air passages, therefore, not only must the relative humidity be raised to as close to 100% as possible but also at the same time the temperature must be raised to as close to 37 C as is compatible with the patient's comfort. To achieve this aim the ordinary steam kettle is more suitable than the mechanical humidifier unless in addition to the humidifier other means are employed to keep the temperature elevated.

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Papillomas of the Larynx with Intraepithelial Anaplastic Changes

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In preceding papers the clinical and histological characteristics of cancer in situ of the larynx were discussed.* Papillomas with anaplastic changes in the epithelium were at that time purposely omitted from the discussion because it had been felt that they deserved a special study.

In an attempt to carry out such an investigation, all the papillomas of the larynx were reviewed which had been seen and treated at the Department of Otolaryngology, Presbyterian Hospital in the City of New York, during a period of 15 years (1939-1953). Only adult patients were dealt with, and the total number of cases observed was 51. Both single and multiple papillomas were reviewed; the relative frequency of the two types, as well as their sex distribution, can be found in Table 1. There is practically no difference between sexes, 28 men and 23 women being affected, but there is a marked difference in the incidence of the two types of papillomas, 38 cases being of the single and 13 of the multiple variety, which represents a ratio of 3:1. This is in accordance with the well-known fact that single papillomas are more frequent in adults, whereas in children the multiple type is predominant. Similarly, Holinger and associates [3] found among 55 adults 35 single and 20 multiple and among 54 children 10 single and 44 multiple papillomas.

The fact that solitary, as well as multiple, papillomas can be the site of the development of typical carcinomas has repeatedly been reported. Jackson and Jackson † observed it in 6 of 205 cases, all adults (3%), and Cunning [6] in 38 of 276 cases (14%). In contrast to these observations, no malignant degeneration was found in any of Holinger's 109 cases, 55 of them adults.[3] Putney [7] noted that in a series of 501 cases of papilloma of the larynx papillary carcinoma was present in 5%; of this group there were 9 cases in which carcinoma developed from a preexisting papilloma, the time interval between the benign and the malignant phases varying from 1 to 23 years. Additional cases with malignant changes were reported by Walsh and Beamer,[8] a boy of 12 and a girl of 13 years, both with multiple papillomas of the larynx since early childhood. The boy died without operation; the girl survived after total laryngectomy. Both children had radio-

TABLE 1.—*Papillomas of Larynx in Adults: Incidence and Sex Distribution in Fifty-One Cases from Presbyterian Hospital, 1939-1953 Inclusive*

Type	Men	Women	Total
Single	23	15	38
Multiple	5	8	13
Total	28	23	51

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From the Departments of Otolaryngology and Surgical Pathology, Columbia University College of Physicians and Surgeons, and the Columbia-Presbyterian Medical Center.

* References 1 and 2.

† References 4 and 5.

TABLE 2.—*Distribution of Eleven Papillomas of Larynx Showing Anaplastic Changes*

Type	Men	Women	Total
Single	7	3	10
Multiple	..	1	1
Total	7	4	11

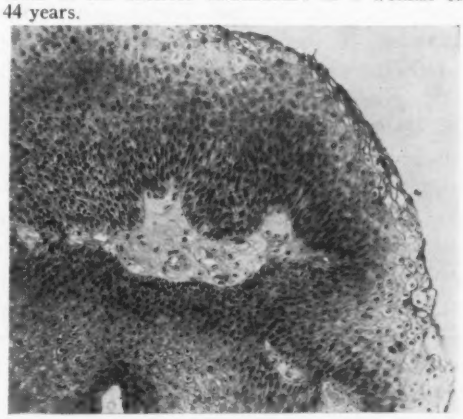
therapy about nine years before the first appearance of malignant changes: The boy received 3270 r in six sessions and the girl 1100 r in two sessions. McCart [9] described the case of a boy of 16 years who died of massive pulmonary hemorrhage. He had had multiple papillomas since the age of 7 and was treated with 9000 r by teleradium without benefit. Tracheotomy was necessary, and numerous laryngoscopies and biopsies followed, with forceps removal of papillomas from the larynx, trachea, and both main bronchi. At the age of 13, infiltrative malignant changes were discovered in a specimen removed from a bronchus. Ogilvie [10] reported two cases—both in adults—of multiple papillomas of the trachea, with metastases to the peritracheal lymph nodes in one of them. Putney and O'Keefe [11] in a discussion on laryngeal keratosis stated that carcinoma was found more frequently in papillary lesions than in the flat lesion with no sharp line of demarcation between the keratosis and the normal mucosa. In those cases which undergo malignant degeneration, the first change commonly observed is the alteration in the intraepithelial cellular structure known as carcinoma in situ. In a man of 52 years with multiple hyperkeratotic papillomas, observed by Matschnig,[12] multiple malignant changes developed seven years after the onset of the symptoms and necessitated laryngectomy.

In our series, 11 of the 51 cases showed anaplastic changes in the epithelium; this amounts to about 22%. In an additional case with hyperkeratotic papillomas a spreading carcinoma in situ with questionable superficial invasion developed, confined to the epithelium. Its history is given later. The distribution of the cases with anaplastic changes can be seen in Table 2. This table shows that the cases with anaplastic changes were, all but one, single papillomas (10:1). The single papillomas were about twice as frequent in men as in women (7:3). The single patient with multiple papillomas was a young woman of 36 years who had had numerous laryngoscopies for the removal of multiple papillomas since the age of 11 years. She had two tracheotomies, one at the age of 20 and the other at the age of 35. At the age of 28 the removed multiple papillomas showed anaplastic changes. Four subsequent biopsies were, however, negative (case of Dr. DeGraaf Woodman).

PATHOLOGY

The microscopic findings in the cases without anaplastic changes followed the general pattern well described in the paper of Holinger and associates.[8] An analysis of the findings in the 11 cases with anaplastic changes in the epithelium reported in this paper shows that the changes consisted mainly of irregularities in the size and shape of the cells, particularly in the basal epithelial layers, with loss of polarity, variations in the size and shape of the nuclei with hyperchromatism, increased number of mitoses, and occasional bizarre mitoses leading to the formation of multinucleated giant cells. The epithelial layers were often thickened, hyperkeratotic, and parakeratotic. The basal membrane remained always intact; the underlying tunica propria might show lymphocytic and plasmocellular infiltration (Figs. 1, 2, and 3).

Fig. 1.—Anaplastic changes in a recurrent papilloma at the anterior commissure in a woman of 44 years.



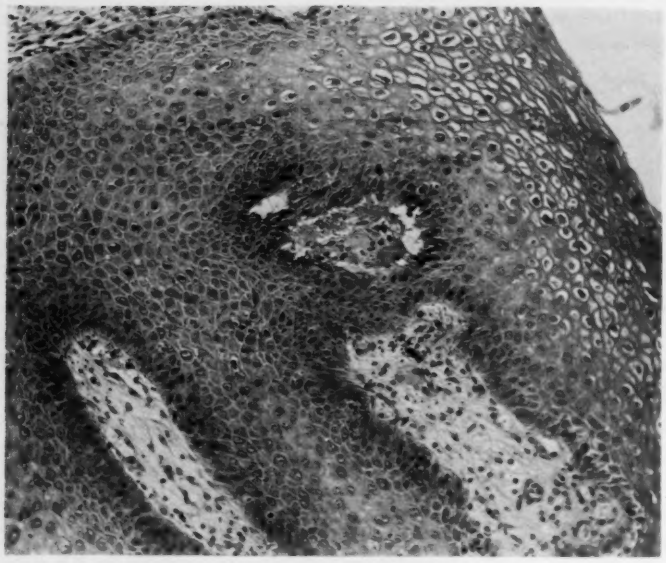


Fig. 2.—Anaplastic changes in a recurrent papilloma of the left vocal cord near the anterior commissure in a woman of 51 years.

In 8 of the 11 cases the anaplastic changes were found within the papillomas. In three of the eight cases they extended into the epithelium adjacent to the papillomas. In the remaining cases anaplastic changes were seen only in the adjacent epithelium.

The degree of the anaplasia showed great variations but was, as a rule, less outspoken than in the cases without papillomatous changes. The anaplastic changes were found either throughout or at various places within the papilloma. The transition toward the normal squamous epithelium was always gradual and not abrupt, as it often is in anaplastic areas within the ordinary stratified squamous epithelium of the larynx.‡ In several instances anaplasia was seen at one time only in recurrent papillomas. In none of the cases could the development of an infiltrating cancer or the formation of metastases be observed. Anaplastic changes in the epithelium of papillomas seem, therefore, less significant and ominous than those developing in the regular laryngeal epithelium. Of special interest are the two cases in which epithelial atypias developed in the squamous epithelium of the vicinity of papillomas (Figs. 4, 5, and 6). The question whether the anaplastic changes and the papillomas in these cases are coincidental or interdependent is difficult to decide, since either occurs, as a rule, without the other. One should, however, remember that the papillomas, no matter where they develop, are always covered with squamous epitheliu n an area originally covered with pseudostratified columnar epithelium, the formation of the papillomas was evidently preceded by the appearance of squamous epithelium in a circumscribed area. Accordingly, one often sees in papillomas re-

Fig. 3.—Anaplastic changes in a recurrent papilloma of the anterior third of the vocal cord in a woman of 39 years.

‡ References 1 and 2.

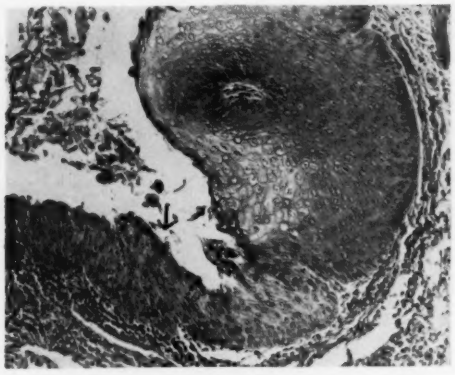


Fig. 4.—Area of carcinoma in situ (arrow) adjacent to a recurrent papilloma of the anterior third of the right vocal cord in a man of 36 years.

moved with adjacent parts of the mucosa that the squamous epithelium covering the stalk of the papilloma extends for varying distances to adjacent parts of the mucosal surface. If anaplastic changes develop in such areas of "metaplastic" squamous epithelium, the papillomas and the anaplastic changes could, perhaps, be regarded in a certain sense as interdependent.

TREATMENT

As far as the cases without anaplastic or straight infiltrative carcinomatous changes are concerned, we simply wish to emphasize that a careful follow-up of the patients is essential, since positive biopsy specimens can be obtained even after many years during which all biopsy specimens had been negative. This is well demonstrated by the fact that in three of our patients the intervals between the very first biopsy and the first positive biopsy were 13, 17, and 20 years, respectively. Radiotherapy was given in 3 of our 39 cases but was unsuccessful in all of them.

The treatment of the 11 cases with intraepithelial anaplasia varied widely. In six cases the suspicious papillomas were removed for biopsy, and in three of them recurrent papillomas failed to show any evidence of malignant change (Fig. 1). The remaining three cases were lost to follow-up,

Fig. 5.—Carcinoma in situ near a recurrent papilloma of the anterior third of the left vocal cord in a woman of 36 years.

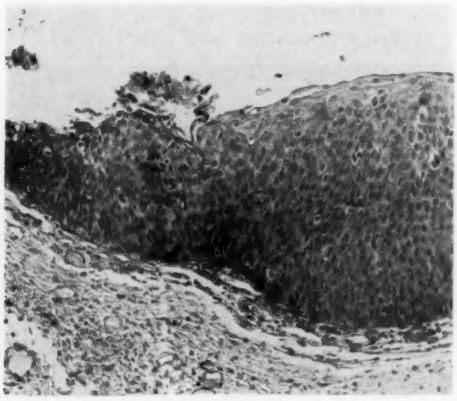


Fig. 6.—Carcinoma in situ extending to a glandular duct in the subglottic area below the anterior third of the right vocal cord in a man of 57 years.

and the final outcome is unknown to us. Of the remaining five, the patient seen by Dr. DeGraaf Woodman (Fig. 3) developed a laryngeal stenosis which necessitated plastic intralaryngeal surgery by the laryngofissure approach. This case was recently reported in detail in a separate paper by Dr. Woodman.[18] Two patients had a regular laryngofissure and two a total laryngectomy. Both patients with laryngofissure had recurrent papillomas of the vocal cords with cancer in situ in the vicinity of the papillomas (Figs. 5 and 6). One of the laryngectomized patients was a man of 36 years with recurrent papillomas of the anterior portion of the

left vocal cord and the subglottic region. When the biopsies revealed the presence of intramucosal carcinoma, laryngectomy was performed (Fig. 4). The histological examination of the larynx showed papillary squamous-cell epithelioma of the intraepithelial type of both cords and the subglottic areas. The second patient was a woman of 41 years with recurrent papillomas of the left vocal cord. The development of intraepithelial anaplastic changes within the papillomas (Fig. 2) was regarded as indication for laryngofissure. The histological examination showed an adequately excised cancer in situ of the left cord. Two years later a recurrent papilloma was removed from the tissue which

Fig. 7.—Hyperkeratotic papilloma of the right vocal cord; low power.

occupied the region of the left cord, and after two more years another papilloma was removed from the same area. Since anaplastic changes were noted in the papilloma, laryngectomy was performed. The histological examination of the specimen showed only a small papilloma near the anterior commissure, covered with squamous epithelium but without definite intraepithelial cancer. Both patients with laryngofissure (six and three years after surgery) and both with total laryngectomy (five and three and a half years after surgery) are well and show, at present, no signs of recurrence.

The already-mentioned case of hyperkeratotic papilloma is reported in greater

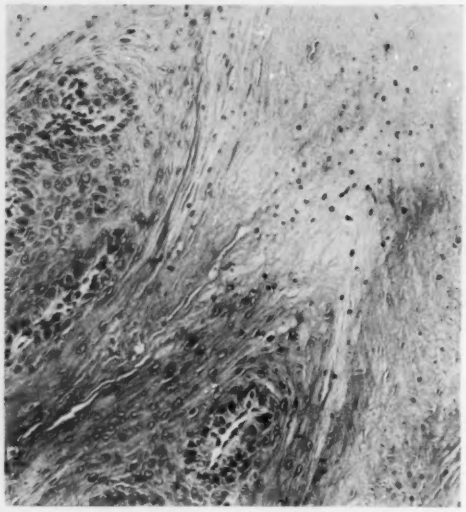


Fig. 8.—Hyperkeratotic papilloma of the right vocal cord; high power.

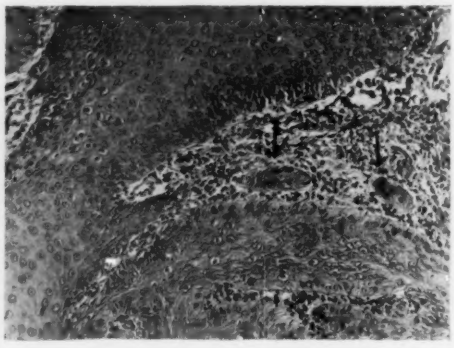
detail because it demonstrates quite well the difficulties sometimes encountered in the proper diagnosis and treatment of such cases.

REPORT OF A CASE

A man, 40 years of age, had had intermittent hoarseness for about 20 years. On examination, June 22, 1944, the entire right vocal cord was found to be covered by a granulating mass which extended backward over the vocal process toward the posterior commissure and downward into the subglottic space. The motion of the cord was impaired. Biopsy showed hyperkeratotic papilloma with changes suggestive of, but without definite evidence of, malignant transformation (Figs. 7 and 8).

The patient was readmitted to the hospital one month later, and another biopsy specimen was taken

Fig. 9.—Hyperkeratotic papilloma of right vocal cord; groups of detached basal cells (arrow).



from the same area and again revealed hyperkeratotic papilloma; on one place there was a very marked cellular infiltrate and some of the basal cells appeared detached. The changes were then interpreted by the pathologist as invasion of the stroma by islands of cells which had undergone malignant transformation (Fig. 9). At present we do not believe there was definite evidence of invasive growth but only of some in situ cancerous changes.

The findings, however, were not regarded by the attending physician as definite enough to warrant more extensive surgery, and the patient was discharged from the hospital.

Four months later he was readmitted with increased hoarseness and complete fixation of the right cord. Another biopsy specimen (Nov. 9, 1944) again showed hyperkeratotic papilloma with carcinoma

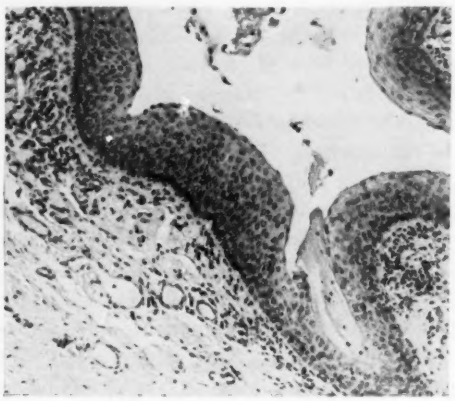


Fig. 10.—Carcinoma in situ in papilloma of right vocal cord.

in situ but without convincing evidence of invasion. Again the pathological findings were not considered definite enough to necessitate surgery.

When the patient was readmitted seven months later, the hoarseness had further increased; examination showed no definite growth of the lesion, but some edema was present around it.

Another biopsy revealed the same hyperkeratotic papilloma as was seen on the preceding biopsies. In one section of the base, however, the tumor was made up of clear-cut squamous epithelial cancer cells which may have invaded the tunica propria for a short distance. The cells were fairly well differentiated and formed pearls with their intercellular bridges preserved but without much keratin.

One month later, more than one year after the first suspicion of malignant transformation had arisen, a laryngofissure was at last performed (July 24, 1945), with removal of the tumor which extended right to the arytenoid cartilage and for a considerable distance into the subglottic space.

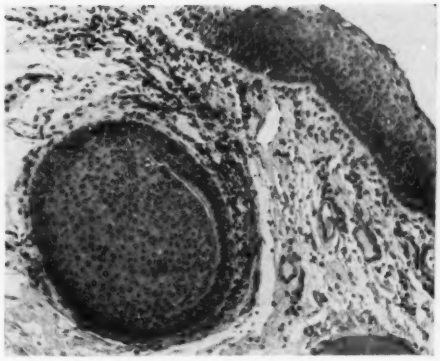


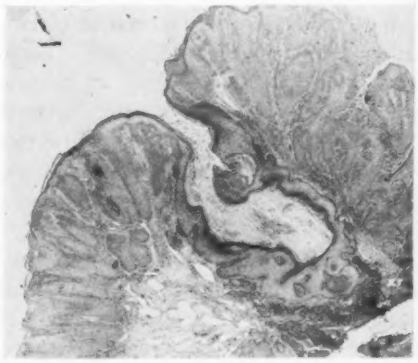
Fig. 11.—Carcinoma in situ in the right subglottic region extending into a glandular duct.

The histological examination showed hyperkeratotic papilloma of the entire cord with carcinoma in situ changes, with marked subepithelial lymphocytic and plasmocellular infiltration, but without convincing evidence of invasion of the tunica propria (Fig. 10). In addition, there were patches of carcinoma in situ not associated with the papillomatosis but of the type we described in the preceding papers.§ It is noteworthy that squamous metaplasia and carcinoma in situ affected some of the glands and ducts (Fig. 11). It was observed that the posterior line of resection had gone through the papilloma, which thus had been removed incompletely. With reliance on the absence of outright malignant changes in the sections from the resected part of the tumor, no further surgery was performed.

Two months later the patient was readmitted with difficulties in breathing and a weight loss of 10 lb. Examination showed a generalized edema of the larynx. Radiotherapy was started, and the pa-

§ References 1 and 2.

Fig. 12.—Papillary carcinoma in situ in the skin surrounding the tracheotomy stoma; low power.



tient received a total of 2000 r as a tissue dose in eight weeks. His respiratory difficulties increased and necessitated tracheotomy.

About one year later a local recurrence developed around the tracheotomy wound. A biopsy specimen showed a typical squamous-cell epithelioma still in situ. It had extended to the skin surrounding the stoma and transformed the epidermis into papillary formations like those seen in the mucosa (Figs. 12 and 13).

The patient died shortly afterward, four years after the first suggestive biopsy; no autopsy could be performed.

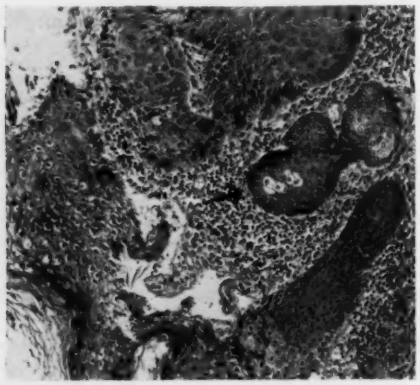


Fig. 13.—Papillary carcinoma in situ in the skin surrounding the tracheotomy stoma; high power. Arrow points to a sebaceous gland of the skin.

COMMENT

In the case presented, laryngofissure at an earlier time, at the first suggestion of invasive growth, or laryngectomy when it was evident that the tumor had been removed incompletely by laryngofissure might have averted the fatal outcome.

We feel unable from our own experience to predict whether radiotherapy can be used successfully in the curative treatment of laryngeal papillomas and papillomatosis because it was used only in palliation or in insufficient dosages to effect a cure. According to Putney,[7] radiation neither eradicates papillomas nor prevents recurrences, though it is of value in some of the keratotic lesions, particularly the nonpapillary type.

The total number of cases observed by us is far too small to permit any definite conclusions. It is, however, our feeling that in those cases in which cancer in situ is present within the epithelium adjacent to, but not within, the papillomas, the same considerations should prevail as those outlined in previous papers || for cancer in situ of the larynx in general.

In none of the nine cases in which the anaplastic changes were found in the papillomas themselves was there, as already mentioned, any evidence of infiltrative growth or of the formation of metastases. In a number of them the changes were observed at one time only and not in papillomas removed at a later date. For that reason, we feel that in most instances the treatment could here be more conservative than in nonpapillomatous lesions. The question arises whether, in these circumstances, the laryngectomy performed on two patients of our series was not too radical a procedure. Since papillary growths do not seem to respond to radiotherapy, the histologically proved presence of cancer in situ on both vocal cords and in the subglottic space in the first of the two patients, in our opinion, fully justifies that intervention. The same consideration holds true for the laryngofissure performed on the second patient; only further experience with a much larger number of patients and over a much longer period of time will determine whether removal of the recurrent papilloma alone and further clinical observation would not have been sufficient at the given moment.

The only statement which can safely be made at present is that, whenever anaplastic changes are noted in papillary growths, a close follow-up with repeated biopsies when necessary is essential; more radical treatment should be started at once when marked spread within the epithelium or even the slightest suggestion of infiltrative growth arises.

SUMMARY

Fifty-one papillomas of the larynx, all of them in adults, are reported. Of the papillomas, 38 were single and 13 multiple. The ratio of men to women was approximately 1:1 (28:23).

|| References 1 and 2.

Eleven cases showed anaplastic changes in the epithelium. In eight of them the changes were seen within the epithelium of the papillomas themselves, in three in the epithelium in the immediate vicinity of the papillomas.

Thorough examination of the biopsy material is essential for the discovery of early anaplastic changes; repeated biopsies are frequently needed since positive findings could, in some instances, be obtained after negative biopsies through many years.

Conservatism in the treatment is stressed, but careful follow-up and surgical treatment are recommended whenever the evidence, or even suggestion, of an invasive lesion is present.

Laryngofissure became necessary in the two cases with cancer in situ in the vicinity of the papillomas; laryngectomy was performed in two of the nine other cases. All the patients operated on are well.

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Prolonged Bronchoclysis

Technique

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The favorable results obtained with intrabronchial instillation of chemotherapeutic products and antibiotics in the treatment of bronchial suppurations, according to our experience and that of others, led us to infer that in some resistant cases and in tuberculous bronchial lesions continuous administration could be useful.

On surveying the current literature, I read a paper by Mendelbaum, according to which the author instilled isotonic aqueous solutions into the bronchus through a semirigid and radiopaque catheter positioned by the transglottical route amounts up to 300 cc., at the rate of 40 drops per minute. The process lasted not more than three hours, and the treatment was carried out daily.

Separately, Winternitz and Smith have demonstrated experimentally with dogs that it is possible to introduce 6 liters of isotonic saline solution in two hours by the intrabronchial route, without evidence of macroscopical or microscopical lesions.

The problem in a prolonged bronchial intubation was to have a tube of small diameter, of a nonirritant material and with a certain rigidity, which would not be expelled by fits of coughing. When polyethylene (Polystan) tubes appeared on the market the answer was found.

Submitted for publication April 11, 1955.

From the Research Institute of the National Academy of Medicine, and Chief of the Bronchological Department of María Ferrer Institute.

EQUIPMENT

A pulverizer for liquids with a movable spout

Two Nélaton catheters, 16 and 20 F., with the ends cut off

A copper-wire mendril to introduce the Nélaton catheter into the trachea

A laryngoscopical mirror

A mirror or frontal light

Anesthetic solution, 2% and 1%, for the mucosa (tetracaine [Pontocaine]-lidocaine [Xylocaine])

One syringe with a curved metal cannula to anesthetize trachea and bronchi

One meter of polyethylene tubing

The polyethylene tubing that may be used for this treatment is available on the market in 0.5, 1, 1.5, and 2 mm. internal diameter. The first trials were carried out with 1 mm. tubes, which were very well tolerated, but after about from 6 to 10 days they became frayed and split in the cavum bend, causing immediate coughing and vomiting. This setback is unimportant if the patient is hospitalized, as the tube can be removed with tweezers and another one substituted. Nevertheless, to obviate trouble altogether we employed 1.5 mm. tubes, which, though causing slight discomfort in the rhinopharynx, will last whatever length of time the treatment may require.

INTRODUCTION OF THE TUBE

A polyethylene tube is introduced into the corresponding bronchial trunk and the other end passed through the nose in order to leave the mouth free. In an initial trial, and with the aid of a bronchoscope, a tube was introduced into the affected bronchus, but this method was discarded because the end of the tube became fixed in the mucosa, which was injured, caused by head movements and coughing. It was then decided to leave the

Fig. 1.—Introduction of Nélaton catheter into the bronchus.

Fig. 3.—Withdrawal of the catheter, leaving tube in place.

end of the tube in the bronchus trunk, homolateral with the lesion, where it was freer, and to put the patient in an adequate position during the instillation so as to place the affected bronchus in a slanting position. This difference in technique does away with the need of a bronchoscope each time the tube is to be introduced.

ANESTHESIA

If a patient is faint-hearted, he may be prepared with barbiturates and codeine; the palate, base of the tongue, oropharynx, rhinopharynx, and nasal fossa are then anesthetized, utilizing 2% tetracaine or lidocaine by slow and systematic pulverization, in order to obtain a good anesthesia with the least quantity of drug, thus avoiding the incidence of reactions.

Thus, with a curved cannula and under laryngoscopical control up to 4 cc. of 1% tetracaine solution or 2% lidocaine is instilled with the precautions mentioned above, the instillation being terminated when the cough reflex is abolished.

POSITION OF THE TUBE IN THE BRONCHUS

When anesthesia is attained, a 20 F. Nélaton catheter with the end cut off is equipped with a copper mandril, and the end is curved to fit the posterior surface of the tongue and can reach the glottis. With the help of laryngoscopical control it is set between the vocal chords (Fig. 1). Then with the left hand the catheter is impelled 10 cm. so that it penetrates the trachea, and, holding it against the dental arch, the mandril is slowly withdrawn. The patient is turned to the corresponding side, and the catheter is introduced to the 25 to 28 cm. mark, according to the patient's stature, the position of the catheter being ascertained by radioscopy. When the catheter is positioned in the re-

Fig. 2.—Introduction of the polyethylene tube into the bronchus.

Fig. 4.—Introduction of Nélaton catheter into the nasal fossa.

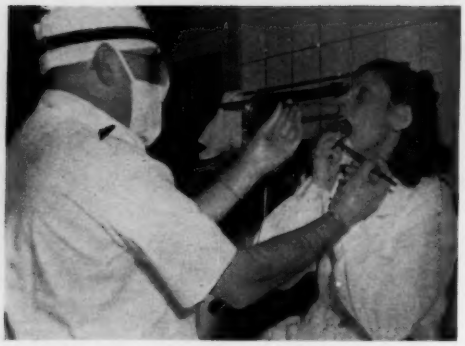

Fig. 5.—Extraction of the oral end of the catheter.

Fig. 7.—Withdrawal of the nasal catheter, maintaining the tube in the rhinopharynx.

quired bronchus, the polyethylene tube is introduced through it (Fig. 2) till it is felt that the end has reached the other end of the catheter. In this condition, holding the tube immovable, the catheter is slowly withdrawn over the tube (Fig. 3). When the distal end of the tube is positioned in the corresponding principal bronchus, the patient himself or an assistant holds it firmly against the upper dental arch, and, through the nasal fossa, previously anesthetized, a 16 F. Nélaton catheter with a cut end is introduced till it can be seen in the rhinopharynx (Fig. 4); from there the end is taken with nippers and brought out through the mouth (Fig. 5). In it the free end of a polyethylene tube is introduced till it is firm (Fig. 6); then the Nélaton catheter is withdrawn, pulling the tube with it. At this stage, it is necessary to fit the polyethylene tube in the rhinopharynx with nippers, in order that the traction upon the free end does not withdraw it from the bronchus and to avoid its folding, which decreases its resistance (Fig. 7). The tube is tractioned till it is well adapted to the rhinopharynx's curve, then it is secured to the side of the nose and forehead (Fig. 8).

INSTILLATION

When the tube is positioned, an injection needle which fits snugly on the end is introduced and the patient is connected to a drop-by-drop infusion system.

The instillation is regulated at a rate of 5 drops per minute, which has proved to be the best tolerated. It does not produce coughing or cause the accumulation of liquid, which tends to cause suffocation. Bearing in mind the purpose of the procedure, the maintenance of a saturated bronchial mucosa does not require, in our opinion, a higher rate. Once the tube is positioned, it is left in posi-

Fig. 6.—Introduction of the free end of the tube into the catheter.

Fig. 8.—The tube positioned.

tion as long as it is considered necessary for the treatment. The patient can sleep, eat, and, disconnected from the infusion system, go back and forth to his home without any inconvenience. In the cases treated by us we have left it in situ from 30 to 60 days, with perfect tolerance.

Bronchoclysis is carried out at intervals so that the patient can eat and rest. The periods of instillation depend on the patient and the lesion. Usually prescribed is an hour of instillation and half an hour of rest during the observation period, and this regimen is later adapted, according to the evolution of the case. If the patient sleeps, the flow of liquid is interrupted during the night.

Once the tube is positioned and the treatment initiated, the new sessions of bronchoclysis do not usually require anesthesia of the bronchus because the mucosa seems to become accustomed to the foreign body and to the slow arrival of the liquid, but if a patient complains of inconvenience 0.5 cc. of 1% tetracaine can be instilled, which will obviate the difficulty. With the objective of avoiding the adherence of fibrous particles of vegetable or animal food to the tube, with the subsequent sensation of suffocation during the treatment, a bland diet is prescribed. This limitation causes a slight loss of weight, which later is rapidly recovered.

INCONVENIENCES

During the first days, the patient experiences soreness of the throat, which may be assuaged with current analgesics and with the instillation of oily balsam nasal drops, in quantities not greater than 3 drops twice a day, in order to avoid lipid pneumonia.

In the first cases also, painful red rhinopharyngitis was present, occurring between the third and the fourth day of treatment, which was treated first and avoided later with the addition of 1000 units of penicillin per cubic centimeter of instilled liquid. Apart from this, the otorhinolaryngologic and bronchoscopic examination carried out after completion of treatment did not reveal any lesion, which was evidence of perfect tolerance.

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News and Comment

ANNOUNCEMENTS

A. M. A. Annual Meeting, Chicago, June 11-15, 1956.—The 105th Annual Meeting of the American Medical Association will be held in Chicago, June 11-15, 1956, with a full program of lectures, television, motion pictures, and scientific exhibits.

The lecture program for each Section is prepared by the Section Secretary, and prospective participants should communicate as soon as possible with the Secretary of the Section before which they hope to read a paper. Application blanks for space in the Scientific Exhibit are now available and may be obtained from the Section Representative to the Scientific Exhibit.

Section on Laryngology, Otology and Rhinology

Secretary: Hugh A. Kuhn, M.D., 112 Rimbach St., Hammond, Ind.

Exhibit Representative: Walter E. Heck, M.D., Stanford University Hospitals, San Francisco 15.

Additional information may be obtained from the Secretary, Council on Scientific Assembly, American Medical Association, 535 N. Dearborn St., Chicago 10.

Scientific Exhibit for Section on Laryngology, Otology and Rhinology.—Applications for space in the Scientific Exhibit, Section on Laryngology, Otology and Rhinology, for the Chicago meeting of the American Medical Association, to be held in June, 1956, must be submitted before Jan. 9, 1956.

Forms for application may be obtained from the Secretary, Council on Scientific Assembly, American Medical Association, 535 N. Dearborn St., Chicago 10, Ill.

The Efficacy of Efocaine in Tonsillectomized Patients

GEORGE F. REED, M.D.
and
WILLIAM W. MONTGOMERY, M.D., Boston

An effective means of controlling the postoperative discomfort of tonsillectomy has long been sought by physicians and patients alike. With the development of long-action depot anesthetics, it was thought that, at long last, such relief might be available. This type of anesthesia had shown great promise in other fields, and reports were published in the literature regarding its use in controlling the postoperative pain of tonsillectomy.

Penn,[1] using 1 to 1.5 cc. on each side, reported excellent results in 45 cases (37 children, 8 adults), stating the results were "most dramatic." A high degree of local pain control was achieved in every instance, lasting five to six days, with no dysphagia or earaches and no untoward complications. Allen,[2] using 3 cc. on each side, also reported very good results in 20 patients, with no complications. Davidson and associates,[3] using 1.5 cc. on one side only, thereby having the other side as a control, did not find such good results. Of eight children having general (open ether) anesthesia, two had no pain in either side, three had equal pain on the two sides, in two the pain was worse on the injected side, and in only one case was there less pain on the injected side. In 19 adults under local anesthesia, they found pain on the injected side worse in 10, bilaterally equal pain in 5, and less pain on the injected side in 4. Campbell,[4] using 2 cc. on each side in 30 adults under local anesthesia, reported good results in 36.7%, moderately good results in 43.3%, and poor results in 20%. He also reported no significant complications but had 2 postoperative hemorrhages in the group of 30. Marks [5] reported 14 cases, using 2 cc. on each side. General anesthesia was used in nine and local anesthesia in five. He found marked relief of postoperative pain, lasting four to five days, in all cases. Six cases had moderate to severe hemorrhage on the 6th to the 24th postoperative day.

In view of this discrepancy of opinions, we decided to conduct a controlled study on the efficacy of Efocaine * in tonsillectomized patients. This was carried out on a series of 90 patients on the ward service at the Massachusetts Eye and Ear Infirmary. Of this group, 63 served as controls and 27 received Efocaine (1 to 1.5 cc. injected into the pillars on each side) at the completion of the tonsillectomy. Great care was taken to make the study as impartial as possible. There was no preselection of cases. Every second to third ward patient who had undergone combined tonsillectomy and adenoidectomy and who had no contraindications was selected at random to receive Efocaine. Neither the patient nor the parents were aware of the nature of the study being carried out or that any special medicine had been used.

During the time of the study, every patient having a tonsillectomy or tonsillectomy and adenoidectomy on the ward service was given a mimeographed form to take home to be filled out by the patient, or by the parent if the patient was a child. The form was explained to the patient or parent by means of an attached mimeographed letter stating that

Submitted for publication May 2, 1955.

From the Department of Otolaryngology of the Massachusetts Eye and Ear Infirmary.

* Efocaine is the trademark of E. Fougera & Co., Inc., New York. It is a solution consisting of the following: procaine, 1%; procaine hydrochloride, 0.25%, and butylaminobenzoate, 5%, in a solvent composed of polyethylene glycol 300, 2%; propylene glycol, 78%, and water.

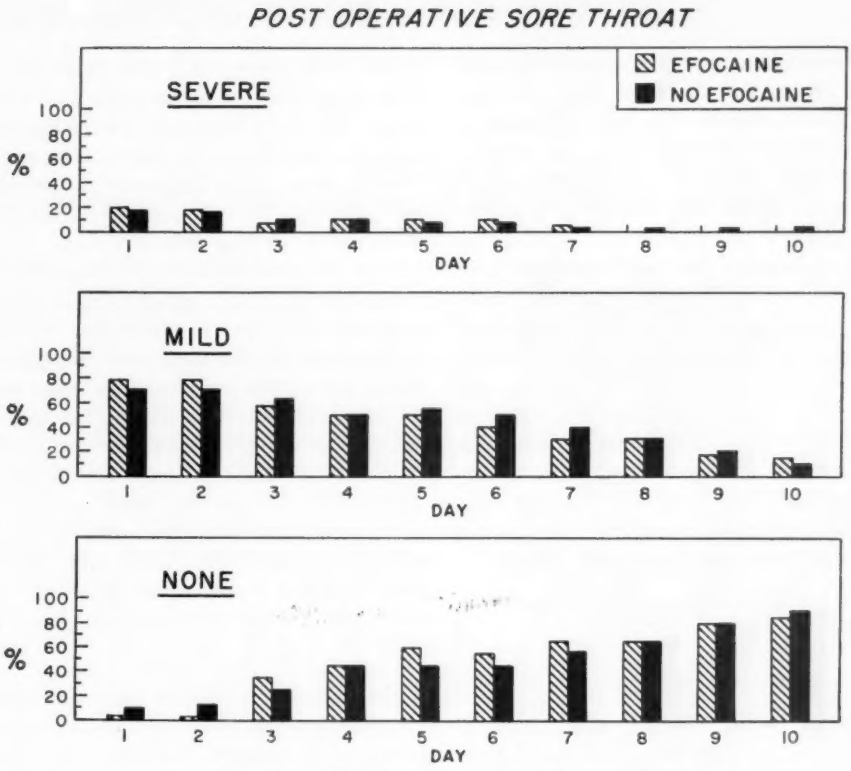

Fig. 1.—Effect of Efocaine upon postoperative sore throat.

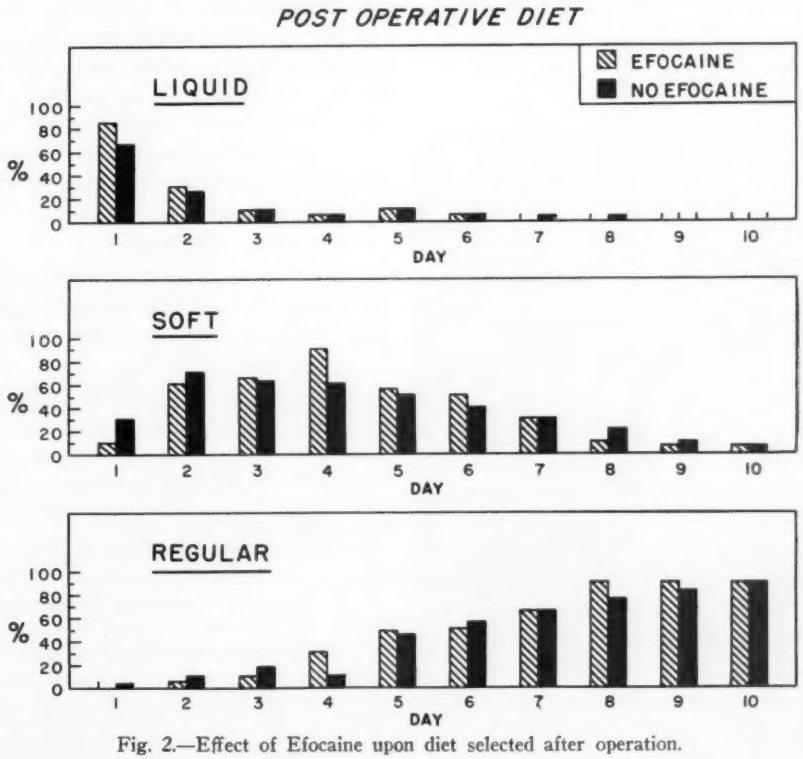

Fig. 2.—Effect of Efocaine upon diet selected after operation.

the purpose of the form was to assist the staff in determining the amount of discomfort experienced by post-tonsillectomized patients. The information obtained from the mimeographed form, which the patient returned to the hospital at the end of 10 postoperative days, included the degree and duration of sore throat, the presence and duration of earache, the type of diet which the patient chose for the first 10 postoperative days, the amount of medication required for postoperative pain, the presence of postoperative bleeding, and the presence of postoperative fever. Many of the mimeographed reports were not returned, and many were returned lacking sufficient information. This accounts for the discrepancy between the number in the control group and the number receiving Efocaine.

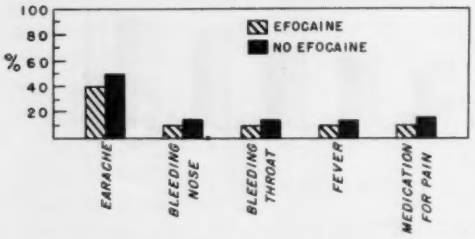

Fig. 3.—Effect of Efocaine upon other postoperative discomfort.

Of the 90 cases studied, the ages varied between 18 months and 29 years. The large bulk of patients were in the age group between 3 and 8 years of age. Only 12 adults were tested: 10 in the control group and 2 in the group receiving Efocaine. The information obtained from the mimeographed forms was carefully transferred to punch cards and the statistical data compiled from these. The results of the data have been tabulated and presented in graphic form in Figures 1, 2, and 3 for the convenience of the reader.

It is evident from these data that in this group of patients we were able to demonstrate no significant differences between the group receiving Efocaine and the group which did not receive it. The depot anesthetic did not appear to have any effect on the amount of postoperative pain or upon the diet which the patient was able to tolerate. We felt that the dietary habit of the postoperative patient would be an additional check against his own estimate of the severity of his sore throat. Nor did it have any appreciable effect upon the incidence of earache, postoperative bleeding, fever, or the amount of pain medication required. No complications attributable to the use of the drug were observed.

Since the resultant figures between the two groups run so closely parallel and in view of the great pains taken to maintain an objective attitude toward this study, we feel that the results are significant despite the small number of cases; however, it is only fair to point out that the tested group was small and a larger group might possibly show different results. We also feel that, since most of the group consisted of children, the results, if valid, are probably applicable only to children. Perhaps a series dealing mainly with adults might show a different response.

SUMMARY

The efficacy of Efocaine in the prevention of post-tonsillectomy pain was studied in a group of 90 patients. Twenty-seven of the total group, most of whom consisted of children between 3 and 8 years of age, received Efocaine at completion of their tonsillectomy and adenoidectomy; 63 served as controls, receiving no Efocaine. No significant effect was observed upon the severity or duration of postoperative sore throat, earache, bleeding, complications, or the amount of medication required for postoperative pain.

243 Charles St. (Dr. Reed).

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Surgery of Carcinoma of the Hypopharynx

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and
IRWIN D. HORWITZ, M.D., Chicago

Changing concepts in the therapy of some forms of head and neck malignant growths have advocated wide and extensive surgical extirpation. Illustrative of this is the radical neck dissection, hemimandibulectomy, and removal of portions of the tongue and floor of the mouth for lesions of the tongue and/or the floor of the mouth; this surgical approach has greatly increased the five-year salvage rate of patients afflicted with these tumors. Equally gratifying has been the experience in the treatment of hypopharyngeal carcinoma.

In the past treatment was almost entirely limited to irradiation. Few patients were able to stand the shock of the surgery, and the morbidity and mortality were so great that few surgeons would operate. Advances in the physiology of fluid balance, anesthesia, and antibiotics have reduced surgical mortality to an almost unconsidered risk. This, plus the disappointing results of irradiation therapy, has encouraged increased attempts at surgical management.

En bloc dissection is the very cornerstone of successful cancer therapy, and with the extension of this concept to tumors of the pharynx, the prospects for more cures have become a real possibility.

We are unable to give at this time any statistical report of five-year cures. Nevertheless, our immediate results are sufficiently important and encouraging to warrant this presentation. We desire to emphasize that adequate surgical excision is generally pos-

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From the Department of Otolaryngology, University of Illinois College of Medicine.

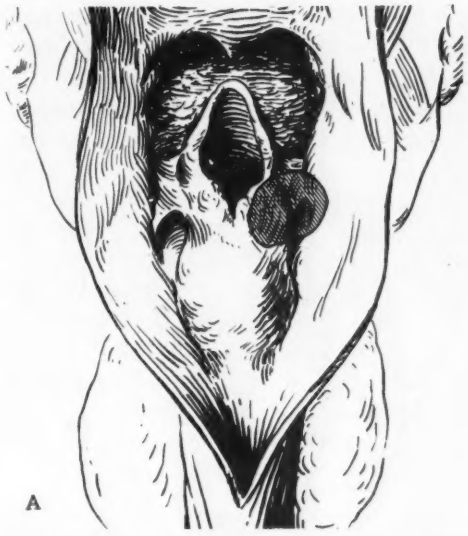
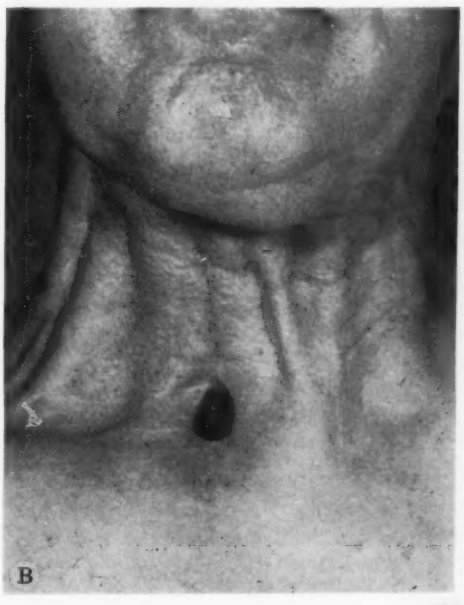


Fig. 1*A* (Group 1).—Schematic drawing shows unilateral position of lesion, permitting primary closure after partial resection of pharynx.

Fig. 1*B* (Group 1).—Postoperative photograph of patient following surgery for lesion, as illustrated in Figure 1*A*.



sible and that, equally important, rehabilitation is neither too long or too difficult.

At the outset we wish to state that surgery is indicated in all cases where it is possible to remove the disease-bearing tissues en bloc. The contraindications to surgery are (1) infraclavicular or distant metastases and (2) fixed "frozen" cervical metastases, which would prevent complete removal of all tumor-bearing tissue.

Conditions which do not definitely contraindicate surgery are a history of cardiac

Fig. 2 (Group 2).—The lesion has extended beyond the midline. However, primary closure is still possible. Radical neck dissection on the more involved side is performed during the resection of the larynx.

pathology, and rostral extension of the tumor into the mesopharynx or even the nasopharynx.

We have classified the various types of cases into three groups.

GROUP ONE

Tumors in Group 1 are limited unilateral hypopharyngeal lesions, without clinical evidence of cervical-node metastases. Surgery consists of a total laryngectomy with adequate removal of the pharyngeal wall but leaving sufficient pharynx for a primary closure. This is combined at the time of surgery with the radical neck dissection on the same side as the lesion (Figs. 1*A* and 1*B*).

GROUP TWO

In tumors of Group 2 the primary lesion of the pharynx extends beyond the midline, without clinical evidence of cervical-node metastases. Surgery consists of a total laryngectomy with a partial pharyngectomy combined with a radical neck dissection on the side of greatest involvement of the pharynx. In these cases, however, sufficient pharyngeal wall usually remains for primary closure. The patient is closely observed, and a radical neck dissection of the opposite side is carried out when and if evidence of metastases appears. In Groups 1 and 2 the presence of ipsilateral metastases at the time of surgery does not alter the procedure (Fig. 2).

GROUP THREE

Lesions of the pharynx with bilateral extension which, after surgery, do not permit the primary closure of the pharynx may be divided into two groups.

Subgroup 1: A strip of pharyngeal mucosa remains in continuity between the esophagus and the mouth. This strip of pharynx is approximated to the edges of the skin incision and will form a part of the future reconstructed esophagus.

Subgroup 2: Total removal of the hypopharynx and larynx is necessary. The skin incision is modified so that in the future construction of the new esophagus this skin flap will form the wall of this new structure.

Where adenopathy is present, a radical neck dissection is included in the primary surgery. In the absence of adenopathy, a radical neck dissection may be deferred until evidence of metastases appears, since one cannot predict on which side of the neck metastases will occur. Figure 3*A* shows the usual type of lesion of the group and illustrates the impossibility of primary closure. Figures 3*B* and 3*C* show the patient postoperatively and in an early phase of the reconstruction of the continuity of mouth and esophagus.

A

Fig. 3*A* (Group 3).—The lesion involves almost the entire circumference of the lower hypopharynx. Primary closure is not feasible.

SURGICAL COMMENT

In every case, the patient is placed under general endotracheal anesthesia. This enables the anesthetist to be placed outside of the operating field, permitting ample room for the operator and his assistants. We do not find it necessary to employ electrocoagulation, since the bleeding factor is not a great one; furthermore, it does not limit the type of general anesthesia to be employed. Some of the salient features of these surgical procedures are the following: 1. The neck must be widely exposed by the creation of ample skin flaps. 2. The hyoid bone, the epiglottis, and the strap muscles are included with the block excision. 3. In the cases of low hypopharyngeal lesions, we always resect that portion of the thyroid gland which is in contact with the pharyngeal musculature. We have found, in some cases where this was not done, recurrence developed within the thyroid gland, and this possibly repre-

Fig. 3*B* (Group 3).—Postoperative photograph following total pharyngolaryngectomy; from above downward are the oral, esophageal, and tracheal stomas.

B

Fig. 3*C* (Group 3).—Final stage of reconstruction of the pharynx. The patient remained well and without evidence of recurrence 18 months following primary surgery.

C

sented permeation of the lesion from the pharynx. 4. With the technique that we employ the pharynx is opened wide on the least involved side, permitting a direct view of the structures within, for it is essential that the margin of normal tissue removed shall be adequate.

CONCLUSIONS

1. Irradiation is very unsatisfactory in the treatment of carcinoma of the pharynx.

2. Surgical management by en bloc dissection of the tumor and its lymphoid bed holds the promise of an increased salvage rate.

3. Reconstructive surgery and rehabilitation can be accomplished without unusual difficulty.

Dr. G. Kenneth Lewis guided and actively participated in the reconstructive phases of the work. A detailed presentation of this work is now in preparation.

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Effect of Meclizine Hydrochloride (Bonamine) upon Vestibular Function

Observations with Notes on Its Value in Comparison with Cyclizine Hydrochloride (Marezine) and Dimenhydrinate (Dramamine)

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and
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Despite the many positive claims that have been made as to the efficacy of the various antivertiginous drugs now available, the search for a more effective compound with fewer side-reactions continues. Ideally, such medication, in addition to exhibiting a high degree of labyrinthine depression, should be relatively free of untoward side-effects and possess an adequate duration of activity, thus eliminating the necessity for frequent administration. The preparation should, of course, be orally active and not interfere with the daily functions of the patient. Needless to say, such a compound has yet to be formulated.

One of the newer drugs suggested for use in disturbances of labyrinthine function and associated disorders is meclizine hydrochloride (Parachloramine, Postafene). Chemically, it is the dihydrochloride of 1-*p*-chlorobenzhydryl-4-*m*-methylbenzylpiperazine, having the accompanying structural formula.

This compound has been found to possess antihistaminic and anticholinergic properties, either activity theoretically having some potential therapeutic value in vertigo and motion sickness.[1] Chinn and associates have concluded from their well-controlled clinical studies on troop ships and in air-borne troops that meclizine affords significant protection and that such protection will persist for 24 hours, with no more than the average amount of side-reactions.* It is the purpose of this study to investigate the action of meclizine on human vestibular function, utilizing objective end-points to characterize the effectiveness of the drug. In addition, some observations on the duration of this action of the drug will be made.

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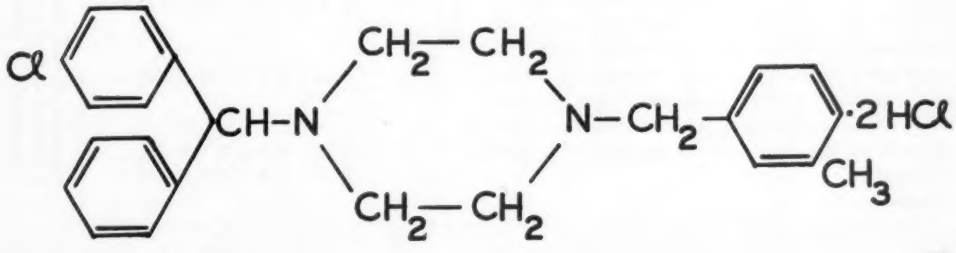
METHOD

The methods previously described were again employed in this investigation and consist of use of the cold microcaloric test and galvanic stimu-

* References 2 to 5.



lation of the mastoid area.† The former involves the placing of 2 cc. of ice water (water with floating ice) into the external auditory canal, with the head inclined laterally so that the ear to be tested is uppermost. The same ear is used throughout all observations. The time for the onset of nystagmus to the contralateral side is accurately recorded with a stop watch, and, at that point, the head is returned to the upright position and the canal emptied of water. The duration of the true nystagmus is then noted. This test measures the sensitivity and responsiveness of the peripheral end-organ in the labyrinth and lends itself readily to repetition because of its simplicity, rapid restoration of the normal state, and relative lack of unpleasantness to the subject. The ratio of the onset to the duration of nystagmus is used as a measure of labyrinthine sensitivity. A decrease in this ratio is indicative of an increased sensitivity, while an increase implies a decreased responsiveness.

The galvanic stimulation test is performed with the subject standing balanced on a tiltboard holding the moistened cathode in one hand while the examiner applies the moistened anode to the contralateral mastoid area. The milliamperage necessary to effect tilting is noted. This method depends upon the integrity and sensitivity of the vestibular nerve tract and associated brain centers; and it, too, is devoid of complexity and rejection by the patient.

Ten ambulatory patients, none of whom presented any abnormalities of the ear, underwent 10 complete trials with 50 mg. (2 tablets) of meclizine hydrochloride. One of the patients was also tested with a 25 mg. dose of the drug. All medications were administered orally. Prior to the ingestion of the drug, three control microcaloric determinations were accomplished at approximately five-minute intervals, followed by a single base line observation on the milliamperage required for tilting. Meclizine was then swallowed, and at approximately 20-minute intervals one microcaloric test and one galvanic stimulation test were done for a total of three such trials, the last of which was usually completed about 75 minutes after administration of medication.

In addition to the above, more prolonged observations were obtained in four ambulatory patients in order to evaluate the duration of action of meclizine. Three base line microcaloric tests and one galvanic stimulation were followed by meclizine orally, two patients receiving 25 mg. and two patients 50 mg. Follow-up observations were then obtained at one hour and six to six and a half hours later.

† References 6 to 8.

TABLE 1.—*Influence of Meclizine Hydrochloride on Vestibular Function Measured by the Cold Microcaloric Method*

Subject	Age, Yr.	Dose, Mg.	Time of Onset of Nystagmus, Sec.					Duration of Nystagmus, Sec.					Ratio of Time of Onset and Duration of Nystagmus	
			Control*	Meclizine			Per Cent of Change	Control*	Meclizine			Per Cent of Change	Control	Meclizine†
				1	2	3			1	2	3			
G. G.	45	25	27‡ (29, 24, 29)	28	45‡	32	67+	106‡ (105, 98, 115)	72	79‡	103	32—	1:3.9	1:1.8
		50	25‡ (25, 25, 24)	39	47‡	49	96+	96‡ (88, 100, 99)	46	41‡	71	57—	1:3.8	1:0.9
C. Z.	56	50	21‡ (19, 21, 23)	19	18‡	116	24—	91‡ (90, 84, 99)	89	102‡	89	12+	1:4.3	1:5.7
M. T.	45	50	27‡ (21, 29, 30)	23‡	23	24	0	67‡ (59, 68, 73)	62‡	66	72	0	1:2.5	1:2.7
R. V.	74	50	27‡ (30, 26, 24)	33	56‡	34	107+	76‡ (71, 68, 90)	89	81‡	76	0	1:2.8	1:1.4
M. O'H.	65	50	25‡ (25, 26, 24)	28	35‡	29	40+	77‡ (75, 78, 77)	75	70‡	74	6—	1:3.1	1:2.0
M. G.	50	50	21‡ (16, 23, 23)	19	13	13‡	38—	79‡ (74, 82, 82)	88	87	88‡	11+	1:3.8	1:6.8
M. de S.	36	50	16‡ (18, 15, 14)	22	25‡	18	56+	69‡ (72, 65, 69)	65	73‡	67	0	1:4.3	1:2.9
F. G.	45	50	18‡ (16, 17, 20)	23‡	16	16	28+	82‡ (67, 82, 97)	77‡	70	90	0	1:4.6	1:3.3
R. D.	36	50	22‡ (22, 24, 21)	30‡	24	22	27+	76‡ (83, 62, 83)	76‡	73	86	13+	1:3.5	1:2.5
J. P.	40	50	22‡ (24, 21, 22)	22‡	19‡	20	14—	94‡ (95, 99, 89)	80‡	103‡	88	15—	1:4.3	1:3.6
												9+		1:5.4

* Average of three determinations.
† Maximal effect of drug.
‡ Components of ratios in last column on right.

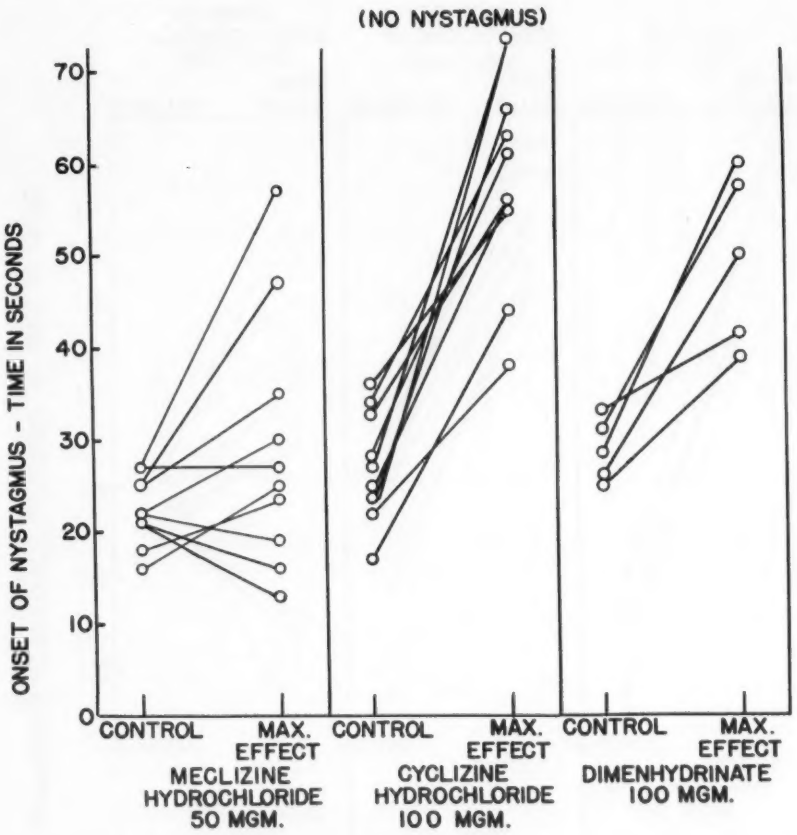


Fig. 1—Effect of antivertiginous drugs upon vestibular function as measured by cold microcaloric method, onset of nystagmus.

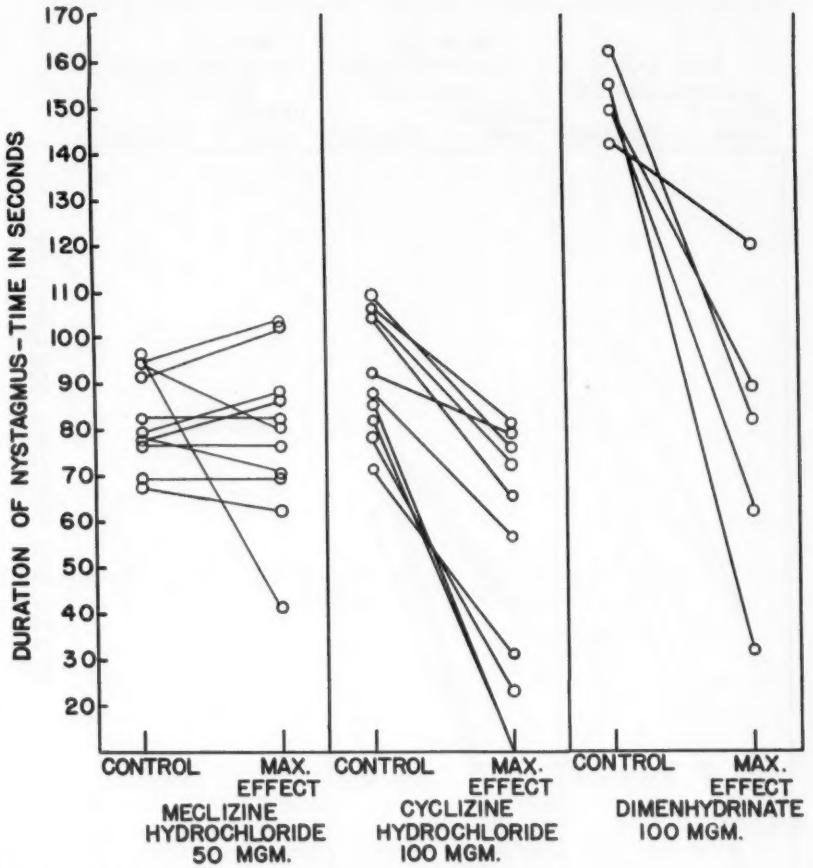


Fig. 2.—Effect of antivertiginous drugs upon vestibular function as measured by cold microcaloric method, duration of nystagmus.

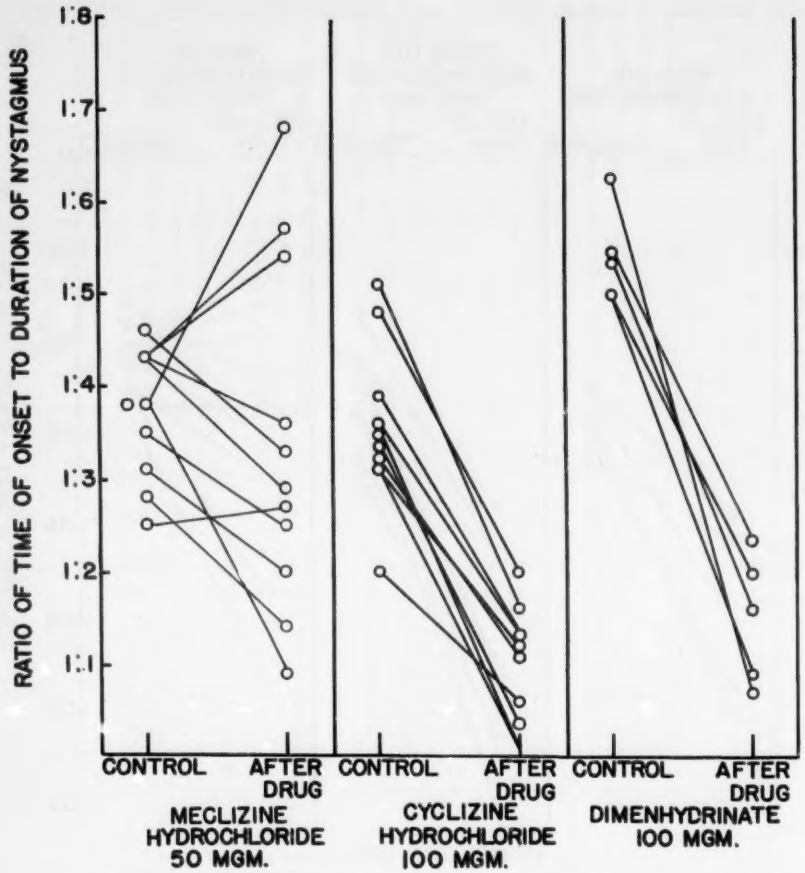


Fig. 3.—Effect of antivertiginous drugs upon vestibular function as measured by cold microcaloric method, ratio of time of onset to duration of nystagmus.

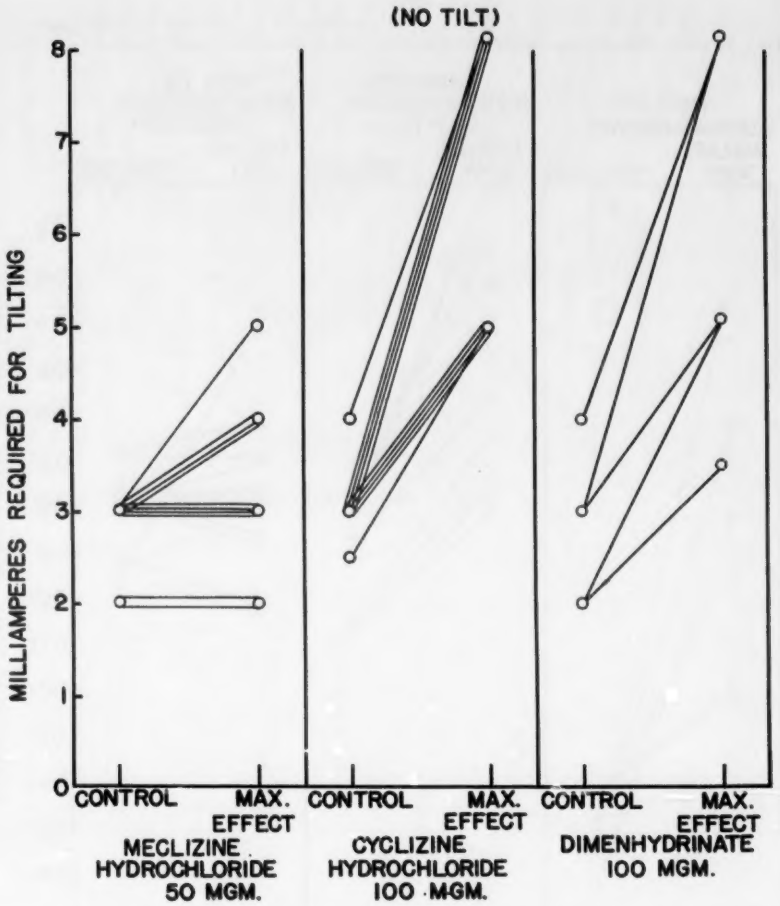


Fig. 4.—Effect of antivertiginous drugs upon vestibular function as measured by galvanic stimulation. (No tilt: failure to tilt despite stimulation with maximal tolerated amperage.)

The effects of meclizine hydrochloride upon the onset and duration of nystagmus and their ratios are presented in Table 1 and Figures 1 to 3. For comparative purposes, 10 representative cases from our previously reported experiences with cyclizine hydrochloride and 5 with dimenhydrinate are included in these figures.‡

The three control determinations for the onset and duration of nystagmus for each patient and their averages are recorded. The testing periods at 20-minute intervals after the administration of the drug are designated by the numbers 1, 2, and 3. The percentages of change were derived by comparing the maximal effect of the drug with the average control figure. The medication was considered as producing no change if any observation noted after ingestion of meclizine fell within the range of the control values or differed from the control reading only by one second. The control ratios were calculated from the average control values, while the ratios following drug administration were based upon the maximal effects (designated by ‡ in the tables for easier interpretation) noted at any one of the three time intervals.

In 6 of 10 trials with 50 mg. of meclizine the onset of nystagmus was prolonged from 10% to 96%; in 3 it was significantly shortened, and in 1 it was unchanged. The duration of nystagmus remained unaltered in

‡ References 9 and 10.

TABLE 2.—*Influence of Meclizine Hydrochloride on Vestibular Function Measured by Galvanic Stimulation Method*

Subject	Age, Yr.	Dosage, Mg.	Milliamperes Required for Tilting				Per Cent of Change
			Control	Meclizine			
				1	2	3	
G. G.	45	25	3	4	4	3	33+
		50	3	4	5	4	67+
J. P.	40	50	3	3	3	3	0
C. Z.	56	50	2	2	2	2	0
M. T.	45	50	2	2	2	2	0
R. V.	74	50	3	3	4	3	33+
M. O'H.	65	50	3	4	4	3	17+
M. G.	50	50	3	3	3	3	0
M. de S.	36	50	3	3	4	3	33+
F. G.	45	50	3	3	3	3	0
R. D.	36	50	3	3	3	3	0

TABLE 3.—*Influence of Meclizine Hydrochloride on Vestibular Function Measured by the Cold Microcaloric Method, Prolonged Study*

Subject	Age, Yr.	Dosage, Mg.	Time of Onset of Nystagmus, Sec.			Per Cent of Change	Duration of Nystagmus, Sec.			Per Cent of Change	Ratio of Time of Onset and Duration of Nystagmus		
			Control	1 Hr.	6-6½ Hr.		Control	1 Hr.	6-6½ Hr.		Control	1 Hr.	6-6½ Hr.
J. G.	59	25	20 (20, 18, 21)	20	21	0	68 (70, 70, 65)	100	63	47+	1:3.4	1:5.0	1:3.0
V. Z.	28	25	14 (15, 14, 13)	20	18	30+	58 (60, 58, 55)	100	60	72+	1:4.1	1:5.0	1:3.3
M. S.	54	50	14 (14, 15, 14)	18	11	29+	76 (80, 72, 55)	70	69	9—	1:5.4	1:3.9	1:6.3
M. D.	27	50	23 (20, 25, 25)	25	20	21— 0	111 (110, 108, 115)	105	106	5—	1:4.9	1:4.2	1:5.3

four instances, prolonged in three, and shortened in two. In the 10th patient the duration was decreased at 20 minutes and increased at 40 minutes. This same variability will be noted in the ratios in this patient. In six patients the resultant ratios were increased, indicative of a decreased labyrinthine responsiveness, which is almost wholly due to the delay in the onset of nystagmus, and in three the ratios were decreased, indicating an increased vestibular reactivity. In the one patient who received both the 25 and the 50 mg. dose, the results reflect a roughly proportionally greater labyrinthine depression with the larger dose in a susceptible person.

TABLE 4.—*Influence of Meclizine Hydrochloride on Vestibular Function Measured by Galvanic Stimulation Method, Prolonged Study*

Subject	Age, Yr.	Dosage, Mg.	Milliamperes Required for Tilting			Per Cent of Change
			Control	1 Hr.	6-6½ Hr.	
J. G.	59	25	3	3	3	0
V. Z.	28	25	2	2	2	0
M. S.	54	50	2	2	2	0
M. D.	27	50	2	2	2	0

In 6 of the 10 trials with 50 mg. the milliamperage necessary to produce tilting was unchanged, while in 4 it was increased (Table 2). The comparison with cyclizine and dimenhydrinate will be noted in Figure 4.

The results of the prolonged study are presented in Tables 3 and 4. It will be observed that with the 25 mg. level in the cold microcaloric test the ratios of onset to duration of nystagmus are decreased at one hour and then increased slightly above control values at the six to six and one-half hour intervals. These observations are completely reversed with the 50 mg. dose. Whether this is a peculiarity of the dose-response curve or a measure of biologic variation cannot be ascertained from the small number of trials completed. The galvanic studies at both dose levels failed to show any alteration or benefit due to the medication.

COMMENT

It is important for the proper orientation of clinical therapy that new medications be thoroughly and objectively evaluated. It was the purpose of this paper to study meclizine hydrochloride by the objective methods previously used in the investigation of purported antivertiginous medicaments. From our experience with these methods and drugs we are inclined to infer that meclizine has some depressant action upon vestibular reactivity but not nearly the reliability, predictability, or magnitude of action of cyclizine or dimenhydrinate in this regard. The observations on its prolonged effects, while admittedly too few to be conclusive, certainly do not substantiate the reported extended duration of action of meclizine.

In the screening of this group of drugs, several investigative approaches are utilized: the clinical testing of human subjects undergoing the stress of sea and air travel, pregnancy, aural operations, etc; the experimental testing of vestibular function in human subjects; the antinauseant and antiemetic evaluations in experimental animals. Because these approaches are attacking different facets of vestibular function, different conclusions may be drawn about the effectiveness of any particular drug in allaying or preventing disturbances in labyrinthine stability. And, as has been emphasized in other communications, clinical effectiveness may be at variance with the objective experimental procedure. These discrepancies were noted in the previous vestibular studies wherein drugs which failed to depress labyrinthine reactivity as measured by our approach apparently were effective when employed therapeutically. Such being the case, conclusions drawn from only one line of investigation must be interpreted largely in the light of that particular methodology. However, where objective laboratory results coincide with subjective clinical evaluations, then the conclusions based upon the experimental data are reinforced and attain greater validity.

We have noted on occasion that a patient who exhibits marked labyrinthine depression may still complain of being "dizzy"; also it would be reasonable to assume that meclizine may relieve vertigo from numerous causations without markedly influencing the end-point used in our methods of studying its action. However, cyclizine and dimenhydrinate are definitely effective medications in motion sickness and allied disorders and, at the same time, definitely reduce labyrinthine sensitivity, as judged by the microcaloric and galvanic tests. And inasmuch as there has been this correlation between the clinical and experimental efficacy of cyclizine and dimenhydrinate and such has not been the case with meclizine, we are forced to conclude that the last-mentioned drug is not of the same order of effectiveness as the former in labyrinthine disturbances.

SUMMARY

Meclizine hydrochloride was studied in 50 mg. dosage by microcaloric and galvanic testing in 10 ambulatory patients.

Meclizine has some depressant action on vestibular function but not nearly the reliability, predictability, or magnitude of such action as cyclizine and dimenhydrinate.

Four observations on its prolonged vestibular depression do not substantiate present clinical reports on the extended duration of action of meclizine.

Caution is advised in the correlation of clinical and experimental vestibular reports; but when both are in agreement, the conclusions are reinforced and of greater validity.

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Audiology Section

JOSEPH SATALOFF, ASSOCIATE EDITOR

Surgical Audiometry in Stapedolysis (Stapes Mobilization)

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The interest of otologists has again been directed to the possible surgical alleviation of otosclerotic deafness by direct attack upon the stapediovestibular articulation. The approach through "stapes mobilization," advocated in the last century by Miot,[1] Blake,[2] Jack,[3] and others, has been recently revived by Rosen,[4] and considerable experimentation with techniques is going on at the present time.

In the attempt to reopen the closed acoustic pathway by manipulation of the stapes or, as I prefer to do, of the entire incudostapedial mass (transincudal stapedolysis), the only guide to progress in the surgical manipulation technique is the subjective response of the patient. It is known to otologic surgeons who work in this field that digital palpation in itself is not the final answer, and that neither the sensation of motion of either stapes or incus nor visualization tells the surgeon whether the closed stapedial vestibular articulation has been reopened for the transmission of sound through the normal sound-conduction pathways. The surgeon relies usually upon the verbal response of the patient (under local anesthesia) to spoken voice. This is, at best, a very crude and unreliable method of "titration" for the "end point."

It is possible, however, through the employment of a simplified version of pure-tone air-conduction audiometry on the operating table to make such a "titration" a reasonable and quantitative technique. I have used the following four-step technique to advantage in 110 stapedolysis procedures. It has provided valuable information on the operating table and reliable confirmation with postoperative findings in a large majority of cases.

It is of interest that the need for surgical determination of hearing status was realized a long time ago. Clarence J. Blake,[5] writing from Boston in 1892, describes operative hearing tests on two patients during stapedectomy. He used the Politzer acoumeter, tuning forks, and the Galton whistle. Gunnar Holmgren [6] published some interesting material on operative audiometry, and G. Nilsson [7] reported some recent experiences following fenestration.

TECHNIQUE OF SURGICAL AUDIOMETRY

Any calibrated and acceptable pure-tone audiometer capable of discrete frequency air-conduction audiometry is satisfactory. No special audiometer is needed for the test. The test can be done quite satisfactorily in the ordinary operating room, provided ambient noise is cut down to a minimum by keeping the doors closed and discouraging unnecessary circulation of personnel in the operating room. The operation is performed with use of local anesthesia, and preoperative medication is limited to a total of 3 grains (0.2 gm.) of pentobarbital sodium, given in divided doses at two hours and one hour before surgery. This is the dose for the average adult, and is occasionally modified according to special needs. Morphine and analogues are not used, and the patient under these circumstances is usually slightly drowsy but sufficiently alert to give accurate pure-tone threshold responses in practically every instance.

The same audiologic technician who performed the preoperative tests is usually pres-

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ent in the operating room, thus giving the patient a certain familiarity with the technique.

The patient is given a push button for response signaling and is instructed in the technique, with which he is by this time quite familiar. The actual administration of the test is done by the simple expedient of spreading a sterile field cover over the entire operative field, including the auricle. An air-conduction receiver is placed over the auricle and is held in place by a sterile towel, usually by the surgeon or scrub nurse. The technician then does a routine threshold sweep for four test frequencies: 500, 1000, 2000, and 4000 cycles. These frequencies have been selected because the information derived from them is usually adequate for detection of significant threshold shifts. Any greater number of frequencies would involve the problem of fatigue and would extend the duration of the test undesirably during a surgical procedure. The exact technique of presentation of stimuli depends entirely upon the practice of the audiologist. Any conventional technique (either ascending or descending intensity) is satisfactory, provided the same technique is used in all steps and in all patients for comparative purposes.

The purpose of surgical audiometry in stapedolysis is the detection of threshold shifts following manipulation of the incudostapedial mass, either by the use of a probe or by the use of a microvibrator, as described by me in a previous paper.[8] In order to make this threshold-shift determination, it is necessary to test hearing at four specific steps in the surgical procedure, and these four steps constitute the minimum required for adequate threshold-shift determination. In some instances, certain of the steps may require repetition and thus as many as seven or eight determinations may be required, but the basic four constitute the minimum.

Step 1

This first step is performed following the completion of the flap elevation and the enucleation of the tympanic annulus from the tympanic sulcus, so that the middle ear has been opened and then closed again, with the skin periosteal flap approximated to the original incision. The necessity of deferring this first step until the middle ear has been opened and then again closed is for the purpose of obtaining a fairly representative audiometric picture of the traumatized tympanic membrane, annular flap, and slightly disturbed incudomalleolar mass (as a result of the manipulation). To do this step prior to the incision and elevation would not give a true picture for comparison at the conclusion of the procedure. Consequently, it is done exactly at the point stated above. This gives us the middle ear closed, or Step 1 reading.

Step 2

The second step is made immediately after the first step by simply reopening the middle ear through rolling the annular flap and posterior half of the tympanic membrane back over the anterior half, exposing the posterior half of the middle ear with its usual landmarks. This is the critical step, which will be used for comparison with Step 3.

Step 3

Step 3 is performed immediately upon completion of an attempted lysis maneuver through the incudostapedial mass. This may involve one or more maneuvers, but the step is done at a time when, in the judgment of the surgeon, sufficient motion has been produced to expect some change. This judgment can be acquired only by experience. The test may be made following responses of the patient to changes in intensity of the surgeon's voice or to room noise.

Step 3 will be compared directly with Step 2 for evidence of threshold shift. A threshold shift of at least 15 db. is usually considered significant if it occurs in at least two of the lower three frequencies. A shift of 20 or 25 db. is more commonly encountered in successful stapedolysis maneuvers. Step 3 may require several repetitions if there is only questionable evidence of stapediovestibular motion. It is not infrequent for

a threshold shift to occur after three separate maneuvers, so that on the third performance of Step 3 a threshold shift may occur which was not present on the first two performances. These threshold shifts may follow either probe or microvibrator manipulations, as previously described.

Occasionally, a slight threshold shift of 10 db. in one or two frequencies may be observed which does not change with subsequent manipulations and subsequent repetitions of Step 3. In such cases, it is frequently advisable to perform Step 4 for direct comparison with Step 1 because in these cases the acoustic contribution of the tympanic membrane and the closed tympanic air space may be quite significant and perhaps greater than in the average patient. In such instances, a 10 db. threshold shift in comparison of Steps 2 and 3 may change to a 25 or 30 db. shift in the comparison of Steps 1 and 4. Usually, however, no such great contribution of the tympanic membrane can be demonstrated in the average case, and the information from Step 3 is the most critical information in the procedure.

Step 4

Step 4 is performed when the drum and annular flap are replaced, as in Step 1, and a comparison is made between the two steps. In most of the successful stapedolysis cases a threshold shift of 25 to 35 db. will be seen in at least two of the three lower frequencies, accompanied by perhaps a lesser threshold shift in the third and possibly the fourth frequency.

Since all these tests are done under conditions other than ideal, it is difficult to equate the threshold in Step 4 with the threshold to be obtained later postoperatively when the tissues have healed and the edema has disappeared, and when the test is performed in the normal sound-treated audiometric room. Usually, one will see an improvement of 10 to 20 db. in the speech range when Step 4 is compared with the first postoperative audiogram, upon the subsidence of the edema.

It must again be emphasized that these threshold determinations are relative and are made for comparative purposes only, and it is realized that they differ significantly from threshold determinations made in a treated room. It is also realized that these thresholds will be improved when the air-conduction receiver is applied closely to the auricle, as it is done in conventional pure-tone audiometry. However, these are threshold determinations for comparative purposes only. The utilization of a sterile field cover between the air-conduction receiver and the auricle is a constant factor, and the responses obtained are for surgical guidance purposes only, and not for ultimate threshold evaluations.

Comment

A number of illustrative examples of surgical audiometry in stapedolysis are shown and described in Tables 1 through 6.

It is interesting to speculate on some of the acoustic information that has been obtained in this surgical audiometric technique. For example, it has been found that a threshold shift with hearing improve-

Table 1.—*Data for Case 41*

	Bone Conduction				Air Conduction			
	500	1000	2000	4000	500	1000	2000	4000
Preoperative audiometry	15	15	20	25	35	35	45	45
Operative audiometry								
Step 1: middle ear closed	..	..	..	..	60	60	40	50
Step 2: middle ear open	..	..	..	..	55	65	45	40
Step 3: stapes mobilized	..	..	..	..	50	50	35	25
Step 4: middle ear closed	..	..	..	..	35	35	30	20
Postoperative audiometry	..	..	..	..	25	20	20	20

This is a good candidate. Note good preoperative bone conduction. Note marked discrepancy between preoperative air conduction and Step 1. This threshold shift is due to operative edema. Note threshold shift in Step 3, with improvement of 5 db. at 500 cycles, 15 db. at 1000 cycles, 10 db. at 2000 cycles, and 15 db. at 4000 cycles. Note more dramatic shift when comparing Steps 1 and 4. Postoperative audiogram shows a good result.

TABLE 2.—*Data for Case 47*

	Bone Conduction				Air Conduction			
	500	1000	2000	4000	500	1000	2000	4000
Preoperative audiometry	25	20	20	10	55	50	50	45
Operative audiometry								
Step 1: middle ear closed	..	..	..	..	55	55	50	50
Step 2: middle ear open	..	..	..	..	55	60	60	45
Step 3: stapes mobilized	..	..	..	..	45	45	35	30
Step 4: middle ear closed	..	..	..	..	25	25	20	20
Postoperative audiometry	..	..	..	..	25	25	20	20

This is a good candidate. Note good preoperative bone conduction. Note close threshold comparisons between preoperative and Step 1 levels. Note threshold shifts between Steps 2 and 3: 10 db. improvement at 500 cycles, 15 db. at 1000 cycles, 25 db. at 2000 cycles, and 15 db. at 4000 cycles. Note identical levels of Step 4 and postoperative audiogram. (This is an uncommon agreement.) The postoperative result is good.

TABLE 3.—*Data for Case 23*

	Bone Conduction				Air Conduction			
	500	1000	2000	4000	500	1000	2000	4000
Preoperative audiometry	15	20	20	20	45	35	35	40
Operative audiometry								
Step 1: middle ear closed	..	..	..	..	60	55	55	65
Step 2: middle ear open	..	..	..	..	70	60	70	75
Step 3: stapes mobilized	..	..	..	..	45	35	45	40
Step 4: middle ear closed	..	..	..	..	45	30	30	40
Postoperative audiometry	..	..	..	..	30	25	25	25

This is a good candidate. Note good bone conduction. Note how operative edema produces threshold shift in Step 1 when compared with preoperative levels. Note significant change in Step 3 when compared with Step 2: 25 db. gain at 500 cycles, 25 db. gain at 1000 cycles, 25 db. gain at 2000 cycles, and 35 db. gain at 4000 cycles. Note consistent improvement on comparison of Steps 1 and 4. Postoperative audiogram shows a good result.

TABLE 4.—*Data for Case 61*

	Bone Conduction				Air Conduction			
	500	1000	2000	4000	500	1000	2000	4000
Preoperative audiometry	20	30	30	15	65	55	80	60
Operative audiometry								
Step 1: middle ear closed	..	..	..	..	55	60	60	70
Step 2: middle ear open	..	..	..	..	55	60	60	40
Step 3: stapes mobilized	..	..	..	..	50	50	60	35
Step 4: middle ear closed	..	..	..	..	45	45	45	40
Postoperative audiometry	..	..	..	..	35	30	35	60

This is a fair candidate. Note fair bone conduction. Note peculiar threshold shift at 4000 cycles in Step 2. There has been a gain of 30 db. at 4000 cycles by simply opening the tympanic cavity. Note only very slight threshold gains in Step 3 when compared with Step 2: 5 db. at 500 cycles, 10 db. at 1000 cycles, 0 db. at 2000 cycles, and 5 db. at 4000 cycles. But note greater differences when comparing Steps 1 and 4: 10 db. at 500 cycles, 15 db. at 1000 cycles, 15 db. at 2000 cycles, and 30 db. at 4000 cycles. Postoperative audiogram shows a fairly good result.

TABLE 5.—*Data for Case 62*

	Bone Conduction				Air Conduction			
	500	1000	2000	4000	500	1000	2000	4000
Preoperative audiometry	10	15	20	45	70	75	75	90
Operative audiometry								
Step 1: middle ear closed	..	..	..	..	80	85	70	95
Step 2: middle ear open	..	..	..	..	70	75	65	85
Step 3: stapes mobilization attempted	..	..	..	..	70	70	60	85
Step 4: middle ear closed	..	..	..	..	80	75	70	95
Postoperative audiometry	..	..	..	..	70	70	75	100

This is a fairly good candidate as determined by preoperative bone conduction. Note lack of improvement in comparison of Steps 2 and 3. Note lack of improvement between Step 1 and Step 4. Note poor postoperative result.

TABLE 6.—*Data for Case 42*

	Bone Conduction				Air Conduction			
	500	1000	2000	4000	500	1000	2000	4000
Preoperative audiometry	30	35	40	45	60	70	70	80
Operative audiometry								
Step 1: middle ear closed	..	..	..	..	65	75	75	90
Step 2: middle ear open	..	..	..	..	70	90	85	75
Step 3: stapes mobilization attempted	..	..	..	..	75	80	90	75
Step 4: middle ear closed	..	..	..	..	85	85	95	85
Postoperative audiometry	..	..	..	..	65	80	85	90

This is a poor candidate with poor preoperative bone conduction. Note no significant improvement on comparison of Steps 2 and 3. Note hearing loss in Step 4 when compared with Step 1. Note poorer postoperative audiogram.

ment at 4000 cycles occurs in the majority of cases when the middle ear is opened (Step 2). This improvement may be anywhere from 10 to 25 db. This difference, however, usually disappears following successful stapedolysis and drops to a lower level, even though the other frequencies may improve following stapedolysis.

The lower three frequencies may change very slightly or drop 10 to 15 db. in Step 2.

A drop or two of blood in the niche of the round window may produce a phase shift change, so that the hearing in Step 4 becomes temporarily poorer than in Step 3. Similarly, blood in the oval-window niche may produce strange threshold shifts at varying frequencies.

Masking of the opposite ear has not been carried out in these determinations because it would probably confuse the patient, who is already slightly sedated by premedication.

Clinical experimentation with direct bone-conduction testing is now under way. Bone-conduction determinations made with a bone-conductor probe extension placed upon the lenticular process of the incus, both before and after stapedolysis attempts, may yield important information.

SUMMARY

The effective performance of stapedial mobilization surgery requires a reliable method for determination of threshold shifts to indicate progress in the surgical manipulation. The uncalibrated nonquantitative use of the surgeon's spoken or whispered voice is indeed a poor technique in the elicitation of such threshold shifts. It is logical that pure-tone audiometry be transferred to the operating room and become a useful tool in this particular surgical approach.

A method is described whereby such determinations can be done, utilizing any acceptable pure-tone audiometer, with the recommendation that four distinct steps be employed for comparative threshold-shift determinations.

Illustrative audiograms are presented to demonstrate some of the findings in the utilization of this technique and the value of such findings when compared with preoperative and postoperative audiometry.

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Congenital Auditory Aphasia

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Speech is dependent upon interpretation of auditory images and upon the motor centers controlling expression. It also depends on the association of these images with the motor centers controlling expression. If one of these mechanisms does not function, we speak of aphasia. In other words, aphasia is a general term including any disturbance of language caused by lesions of the brain and not resulting from faulty peripheral innervation of the speech muscles or from mental deficiency.

Aphasia in adults has been known for more than a hundred years. Wernicke, in 1874, described what is known today as sensory or auditory asphasia and differentiated this condition from motor aphasia. He described this kind of aphasia as a loss of comprehension of words due to abolition of sound images, caused by a lesion in the left superior temporal gyrus. He called this condition word deafness. The patient can still hear, he recognizes voices, but he cannot repeat what he hears. He can read and may be able to speak spontaneously, usually in senseless combinations, unintelligible words, and gibberish sounds because he does not comprehend the significance of his own words. We all have seen this condition following cerebral hemorrhages or other circulatory disturbances of the brain, and usually it is not very difficult to diagnose this condition in grown-ups.

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The situation is quite different in children, especially in young children, when there is a congenital defect of the central nervous system leading to faulty speech development or congenital aphasia. Here, the diagnosis and recognition of this condition present quite a complicated problem. The common causes of absence of speech after the age of 2 to 2½ years are mental retardation, hearing disabilities, and functional disturbances resulting from fear reactions or other emotional factors. These three causes of delayed speech will have to be excluded before a diagnosis of congenital auditory aphasia can be considered. In other words, there are children of normal mental development who have normal emotions with more or less normal hearing and no physical or neurological disabilities who do not talk. It is most important to detect these children and to separate them from the deaf or feeble-minded because their speech can be developed by appropriate therapy. As far as the mental status is concerned, psychometric and intelligence tests will reveal that these children have an average, and often above average, I.Q. and that they have a normal mental age.

The biggest and most important problem in these children who are very young is to test their hearing. The parents usually will have observed that the child reacts to noise, but they are puzzled because the child does not understand or respond to spoken words; after a while, they make up their minds that their child is deaf, and, unfortunately, often the physician confirms their diagnosis. It is well known that hearing testing, even in a normal young child, is a difficult undertaking; but in a child that does not speak, it is more or less impossible to obtain reliable information from audiometric exam-

inations based on subjective responses. The development of an objective hearing test by Hardy and Bordley, that is, the psychogalvanic skin resistance test, at the Johns Hopkins Hospital was therefore a big help in the discovery of cases of congenital auditory aphasia.

Since so much depends for these children on convincing proof that they can hear, I would like to discuss the psychogalvanic skin resistance test and objective hearing tests in general. The problem is to find a reaction of the organism to sound that is constant and independent of the will and consciousness of the subject to be tested. Such a reaction must obviously be reflex in nature. Galvanic skin resistance changes were known to occur in hysterics since 1888. It was found by Feré that psychic excitations could decrease the resistance of the skin to very small electrical currents by an increase in local sweating. This phenomenon was used in various psychological tests. Michels and Randt in 1947 used an electroencephalograph to record psychogalvanic skin resistance changes following auditory stimuli from an audiometer in soldiers and were able to differentiate psychogenic deafness from organic deafness. They obtained good results only with frequencies from 1000 to 2000 cycles and by applying very high intensities. This method was not suitable to obtain auditory thresholds. A more reliable test and one applicable to infants and children was developed at the Johns Hopkins Hospital. The auditory stimulus is followed at a few seconds' interval by a slight faradic shock. The faradic shock is constantly followed by a drop in skin resistance, due to sympathetic stimulation leading to increased activity of the sweat glands. If the faradic shock is always preceded by an auditory stimulus, a conditioned reflex is created, and after a certain number of sessions, the auditory stimulus alone is followed by a decrease of skin resistance.

As far as the technique of this test is concerned, I quote the authors:

> Zinc or solder electrodes about three quarters of an inch in diameter are coated with a viscous solution of kaolin saturated with Zinc Sulfate and applied to the sole and instep of the child's foot; they are held in place by a gauze pad and adhesive tape. These electrodes are employed to pick up changes in voltage which result from the activity of the sympathetic nervous system under stimulation. This activity is registered as a decrease in the resistance of the skin to the passage of a minute electric current between the electrodes. These pickup electrodes convey the voltage changes through a Wheatstone Bridge circuit to a standard direct current amplifier. The amplifier output is connected to a recording ammeter which makes an inked record of the amplified responses of the sympathetic nervous system. The acoustic signal from an audiometer is followed in about three seconds by a mild faradic shock. It it important that the child is kept warm during the tests in order to avoid interference with the activity of the sweat glands.

Bordley and Hardy state that about 8 to 12 combined signals are necessary to set up a conditioned reflex arc. After that number of sessions two breaks appear in the skin resistance tracing: one after the sound and another one after the shock. Once the conditioned reflex arc is established, the intensity of the sound is gradually lowered until a threshold is reached for the various frequencies. The same authors state that there is only a 2½ to 4½ db. variation between the audiograms obtained by psychogalvanic skin resistance tests and those obtained by subjective means in normal persons.

Quite a bit has been said about the reliability of this test. It is obvious that we are not dealing with a test of mathematical precision. The inventors of the test, themselves, consider it only as one step in the clinical work-up and insist on a careful clinical history, physical examination, and evaluation of physical and social development in every case of hearing loss. There are the problems of wandering of attention during the test and of false-positive responses from emotions other than those produced by the auditory stimulation.

Knapp and Gold report their experience with the psychogalvanic skin resistance test in 121 military subjects in whom they were able to differentiate between physiological and psychogenic hearing loss. The two kinds were often present in the same subject, lead-

ing to so-called mixed deafness, not to be confused with mixed conduction and perception deafness. They found that normally the threshold for skin response is about 5 db. lower than the threshold for voice discrimination by the ear. They also found agreement between their clinical diagnosis and the test results in more than 90%. Out of 42 cases found to have psychogenic hearing loss, they were able to restore hearing through psychotherapy in 21. This would be an absolute and final confirmation of their diagnosis. The other 21 cases were not treated intensively. One interesting feature of their work is the discovery of the so-called mixed cases, that is, cases where a psychogenic component is superimposed on an organic hearing loss. In these cases they found a gap of 25 to 30 db. between the threshold obtained with the psychogalvanic test and the subjective speech discrimination. Intensive psychotherapy could lower the threshold of these patients considerably.

These authors also point out the difficulties and problems of the test, such as the variability of the reactivity of the skin, the interference of extraneous stimuli, and the element of fatigue leading to diminishing returns after repeated stimulation. Knapp and Gold did not use faradic shocks on their patients and therefore did not establish a conditioned reflex arc. They, themselves, consider the introduction of the faradic shock a considerable improvement of the method, likely to eliminate many elements of error and failure of the test.

I have discussed at some length the psychogalvanic skin resistance test because the diagnosis of congenital auditory aphasia stands and falls with the objective proof that the child has normal or almost normal hearing. The integrity of the sensory end-organ and the auditory pathways must be established before this diagnosis can be made. The following case history will illustrate this point.

The child, 4½ years old, was born in West Virginia after an eight-month pregnancy. The birth weight was 5½ lb. Labor, delivery, and feeding were normal. There was nothing of significance in the family history except for one brother affected with rheumatic heart disease. Development of the child was entirely normal. Sitting, crawling, and walking occurred at a normal age. The only abnormality was that the child did not talk but only jabbered. The child pointed to objects she wanted. The family, apparently, had a rather low social status, and at the age of 2 the child was given to friends and since then had traveled quite a bit in West Virginia, Ohio, and Maryland.

The child was seen at the pediatric clinic of a local hospital. The physical examination was entirely negative except for the absence of speech and an inconstant left strabismus. Weight was 36½ lb. and height 39½ in. The child was referred to the speech center of the Johns Hopkins Hospital with a diagnosis of deafness. The following is the result of the psychogalvanic skin resistance test:

"Very difficult to establish the conditioned response, but after being conditioned, the child gave both psychogalvanic and overt (generally plantar flexion plus a yell) responses to the tones. The threshold differences between ears may represent the effect of better conditioning rather than a real difference in auditory acuity, since the right ear was tested first. The thresholds are considered sufficiently accurate to indicate normal end-organ hearing.

"Impression: In view of the peri- and postnatal history and behavioral patterns there is a strong likelihood of some brain damage resulting in auditory aphasia."

The following report of an encephalogram taken on this patient is also quite interesting:

"The patient received 50 milligrams of Seconal [secobarbital] orally three quarters of an hour before the start of the record. With 18 electrodes the induced sleep record on this child shows primarily moderate voltage: 20/sec. activity in all areas. There is a definite preponderance of this activity showing phase reversal localization in the left temporal tip. However, there is a small amount in the right low central and temporal area, which appears a little higher voltage than other areas, except for the left temporal tip.

"Comments: Though this evidence is suggestive of some irritative lesion in the left temporal tip, I do not feel that the pattern is consistent enough, nor clear enough to warrant any diagnosis being made on this evidence alone."

This is the report of the ENT consultation:

"Child is 4½ years old and can't speak. Had psychogalvanic tests at Johns Hopkins Hospital which were allegedly normal. Patient also had EEG.

"Ears: Canals and drums normal.

"Nose: Mildly congested with some crusting.

"Nasopharynx and throat: Show moderate hypertrophic tonsils and adenoids.

"Impression: deferred.

"With the degree of obvious 'hearing loss' which this child shows it is very doubtful whether any ENT pathology seen at this time is contributory to her condition. Unless the child has an auditory aphasia, I would be inclined to recheck the psychogalvanic tests. There is the possibility of error."

As it is usual in these cases, the child was referred to the ENT department with a diagnosis of deafness. There was no ENT pathology, and the psychogalvanic skin resistance test revealed normal end-organ hearing. We find in this history that abnormal behavior is mentioned by several consultants. However, abnormal behavior in these children does not necessarily mean mental deficiency, since neglect, emotional trauma, and faulty treatment of these children might very well lead to marked antisocial tendencies and abnormal mental development, which, however, will straighten out miraculously once the real pathology is recognized and appropriate treatment begun. It is therefore of the utmost importance to obtain a very careful and specialized psychological and psychiatric evaluation of these children, including determination of the I.Q. and the mental age, which should be normal or slightly below in a pure case of congenital auditory aphasia. Unfortunately, this was not done in this case owing to the child's leaving town, and therefore a final diagnosis cannot be made, but the history is certainly very suggestive of congenital auditory aphasia.

Another case has been reported by Karlin, in 1951. This child also was referred for speech and hearing defect. There was nothing of significance in the family history; pregnancy and labor were normal. Physical and social development was also normal, except that the child did not speak until the age of 4 years, and then only a few words. The parents and the family physician had the impression that the child did hear but also that it read lips. However, two otolaryngologists performed audiometer tests and diagnosed a 95% deafness. There was no hearing improvement after tonsillectomy and adenoidectomy; radium therapy was unsuccessful, as was a hearing aid, which the child refused to wear, complaining of too much discomfort. Careful psychometric examination revealed an approximately normal intelligence. X-rays and encephalogram were normal. It was obvious, however, that the child had better hearing than the audiograms would indicate, since the child did acquire some speech without help and also was able to pick toys by their sounds. To solve this hearing problem, the child was sent to the Johns Hopkins Hospital for a psychogalvanic skin resistance test. The psychogalvanic audiogram revealed a hearing loss for the speech frequencies of 20, 20, and 25 db. for the right ear and of 35, 40, and 70 db. for the left ear. Since the test was given without faradic shock and no conditioned reflex was established, these values cannot be considered as thresholds, but they reveal definite hearing for the speech frequencies. The author concluded that he was dealing with a central defect in auditory and language function.

Another case of congenital auditory aphasia was reported by Van Gelder, Kennedy, and Laguaite in the *New Orleans Medical and Surgical Journal* in December, 1951. The family history was noncontributory. During the third month of pregnancy, the mother had an exanthematous virus disease with lymphadenitis, which must have been rubella, though the family physician made a diagnosis of infectious mononucleosis. Labor was normal. The baby was a constant feeding problem, and physical and motor development was somewhat delayed. As the child did not talk at the age of 3 years, he was referred to the speech clinic with a diagnosis of hearing impairment. A psychologist had previously diagnosed a generalized and hopeless mental deficiency and advised institutional care. A more careful and specialized mental evaluation, however, came to very different conclusions. His mental capacity was found to be at least average. The child was found to be alert, attentive, and responsive and to have good discriminative judgment. Social age was found to be normal, and there were only a few behavior problems.

Hearing examination revealed that the patient had normal hearing and voice quality. The authors do not say how they arrived at this conclusion, nor do they report which tests they employed. They made a diagnosis of predominantly receptive aphasia with mild expressive involvement. Intensive speech training was rewarded by great improvement, and the authors state that after 10 months of therapy, his vocabulary increased from 2 or 3 garbled words to 110 words.

The same writers also made a survey among 45 speech therapists, inquiring about their experience with infantile aphasia. Only 17 answered the questionnaire. Six replied that they were unable to observe such cases. Five replied that they had encountered such cases but reports were not available. One speech therapist had no occasion to resort to that diagnosis. Five remaining speech therapists returned 34 case reports. Of these 34 cases, 18 had been referred to the speech clinic with a diagnosis of deafness, 11 with a diagnosis of mental retardation, and 3 as emotional problems, before the diagnosis of aphasia was made.

The three cases which have been reported confirm the result of this survey, namely, that the aphasic child is commonly labeled as deaf or mentally retarded or both. Since it will have catastrophic consequences to send a normal child into a mental institution or a child with normal hearing to a school for the deaf, the importance of recognizing congenital auditory aphasia as early as possible is obvious. These cases are apparently much more frequent than we think. Many children 4 to 5 years old with delayed speech might suffer from a mild degree of aphasia. It seems to be worth while to submit all children with speech difficulties to psychogalvanic testing and specialized mental evaluation. This is all the more important, since these children seem to respond very well to adequate treatment. All the papers I have reviewed on this subject report good results with speech therapy given by trained speech technicians. The parents must cooperate by continuously stimulating the child's speech through interesting games and by talking to the child. The child should be treated as a normally developed child in every way. Hearing aids, of course, are not indicated,

A few words should be mentioned about the etiology and pathology of this condition. As far as the etiology is concerned, since most cases are congenital, one can only speculate. In Van Gelder's survey the following possible causative factors were listed: prenatal virus diseases, birth injuries, cerebral anoxia, prematurity, and encephalitis. We also have to consider cerebral hemorrhages and other congenital vascular diseases and also incompatibility between various blood types, such as erythroblastosis fetalis. Several authors state there is a familial trend in a large proportion of cases.

Much has been written about the underlying pathology, but since there are no autopsy reports of these cases, one can only speculate here too. Since there is no evidence of conductive or perceptive deafness, we do not look for any pathology in the organ of hearing or the acoustic nerve. The defect is limited to the function of language and, especially, to the understanding of language. We think of language in terms of cerebral cortex, but which part of the cerebral cortex is affected is by no means clear. Acoustic impulses, after having reached the cochlear nuclei, travel through the lateral lemniscus to the medial geniculate body. From there, the auditory radiation ascends in the internal capsule to the cortex of the temporal lobe. According to Best and Taylor, the first relay station in the temporal lobe is the transverse gyrus of Heschl in the floor of the Sylvian fissure. Here, intensity and pitch of the auditory stimulus are appreciated, but no interpretation or analysis of sound takes place. This area should also function normally in aphasia. From Heschl's gyrus the auditory impulses travel to the superior temporal convolution, where language is recognized. Worster-Drought and Allen, who have reported quite a few cases of congenital auditory aphasia, believe that the cause is an aplasia of the posterior third of the su-

perior temporal convolution. That is where the lesions are found in adults presenting signs of perceptive aphasia. This area is also known as Wernicke's area. These authors believed that the lesions would have to be bilateral, since each acoustic nerve is relayed to both hemispheres. Modern neurologists, however, agree that unilateral lesions are sufficient to produce language disturbances. It is obvious that such a complicated and highly mental function as language cannot be limited to one single cerebral area. It seems that connections and associations involving the whole cerebral cortex have to cooperate in the understanding and interpretation of language. That, at least, is the conception of modern neurology. It may be that cortical areas very distant from the temporal lobe are involved in the pathogenesis of congenital auditory aphasia.

The psychogalvanic skin resistance test is obviously based on a reflex with afferent stimuli traveling along the auditory nerve and efferent stimuli traveling along the sympathetic, leading to increased sweating. We do not know where the connections between afferent and efferent impulses take place, most likely rather low in the central nervous system, probably in the brain stem. A normal psychogalvanic audiogram suggests, therefore, integrity of the auditory pathways up to the brain stem but is of little help in the localization of lesions above this level. This is confirmed by the fact that auditory aphasia, or rather agnosia, is not limited to defective recognition of words. Very often, these children are also unable to recognize much more primitive sounds, pointing to lesions in subcortical areas, and yet the psychogalvanic test shows that these children do hear.

Concluding this paper, I wish to stress the fact that congenital auditory aphasia seems to be much more frequent than it is generally thought, though only about 70 cases have been reported in the literature so far, most of them before the use of psychogalvanic skin resistance tests. This test appears to be a powerful weapon in the diagnosis of these cases and should be employed freely in young children with hearing and speech difficulties. It is especially dangerous to label a child mentally defective only because he cannot talk or understand spoken language. It is equally dangerous to consider these children as hopelessly deaf. Wallin summed the situation up in these clever words:

> The difficulty is not of auditory perception of the spoken sound but the recognition of the acoustic word imagery. Speech sounds to the word deaf like a foreign language, a meaningless jargon of sounds. One may well imagine the difficulty which a highly intelligent adult would find in repeating a long sentence in a totally unfamiliar language. He would certainly not be considered as stupid if he only managed the last few words of the sentence.

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The Measurement of Auditory Recruitment

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Auditory recruitment is a condition in which certain defective ears are more sensitive to changes in intensity of sound than are normal ears. This characteristic usually manifests itself in at least two ways. One feature of it is a sudden detection and distinct awareness of the threshold of sound in an ear with recruitment as compared with a gradual and uncertain onset of threshold in a normal ear. Another manifestation is that at succeeding levels above threshold the difference in loudness for a tone of given intensity between an ear with recruitment and a normal ear tends to diminish and disappear. For example, a tone of 40 to 50 db. above threshold in an ear with recruitment might seem as loud as the same tone at 100 db. above threshold in a normal ear.

In recent years the detection and measurement of auditory recruitment has become an important aspect of audiometry. It is used by many otologists as an aid in diagnosing the types of deafness encountered and in evaluating the effectiveness of treatment. Audiologists use recruitment as an index to tolerance and discrimination of amplified sound and, hence, as an aid in evaluating and selecting hearing aids. It is thought that investigation of the recruitment phenomenon may shed light on the problems of auditory physiology as well as elucidate some of the psychologic aberrations of auditory behavior. While there is keen interest in this subject, coupled with a considerable volume of experimental and theoretical data, there is yet no completely satisfactory explanation for all the manifestations that appear to be related to the recruitment phenomenon.

The present paper makes no claim of clarifying the obscure points nor of unifying diverse opinions on the subject. Rather, the intent here is to describe the several characteristics of audition thought to be indicative of recruitment and to review the procedures employed in measuring these characteristics.

In 1924 Pohlman and Kranz reported a procedure and results which probably demonstrated auditory recruitment, although it was not so named. Using an audio-oscillator to produce pure tones at carefully controlled intensities, they found that a person with a tonal gap in his audiogram at threshold did not notice this gap at high intensities. In reporting their observation, they described what undoubtedly was recruitment of loudness as follows: "Once the threshold of such a range of decreased acuity is attained it takes comparatively little additional energy to cause the deficiency to seemingly disappear quite completely."

THE ALTERNATE BINAURAL LOUDNESS-BALANCE TEST

In 1928 Fowler described and labeled the phenomenon of auditory recruitment and presented it as a practical test for distinguishing between conductive and nerve-type deafness. He recognized also that there were different rates and degrees of recruitment, including overrecruitment, which is charac-

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terized by a defective ear requiring less intensity at high levels than a normal ear for equal loudness. In this variety of manifestations of the phenomenon Fowler foresaw the possibility of more refined diagnosis. He thought it might be possible with this test to distinguish between lesions at various points along the auditory pathway.

The method of measurement propounded by Fowler is known as the "alternate binaural loudness-balance test." It has been adopted widely as a tool for both clinical and experimental investigation of the loudness function in normal and abnormal ears. The procedure employed is that of matching the loudness of a given tone in the two ears. A person who has an impairment of one ear while the other is normal or more nearly so will exhibit a difference in the intensity required to reach threshold in the two ears. If this difference is constant in matching loudness at succeeding levels above threshold, there is thought to be no recruitment. If the difference apparent at threshold is not maintained but gradually decreases at higher levels, recruitment is thought to be present in the impaired ear. Figure 1 illustrates a means frequently used to represent the binaural loudness-balance measurement. Figure 1*A* is a hypothetical audiogram showing normal acuity in the right ear and a marked loss of hearing in the left ear. Figure 1*B*, with parallel lines showing symmetrical increase of loudness, is interpreted as indicating no recruitment. Figure 1*C*, with lines changing from sloping to horizontal position, showing rapid increase of loudness in the left ear, indicates recruitment in the

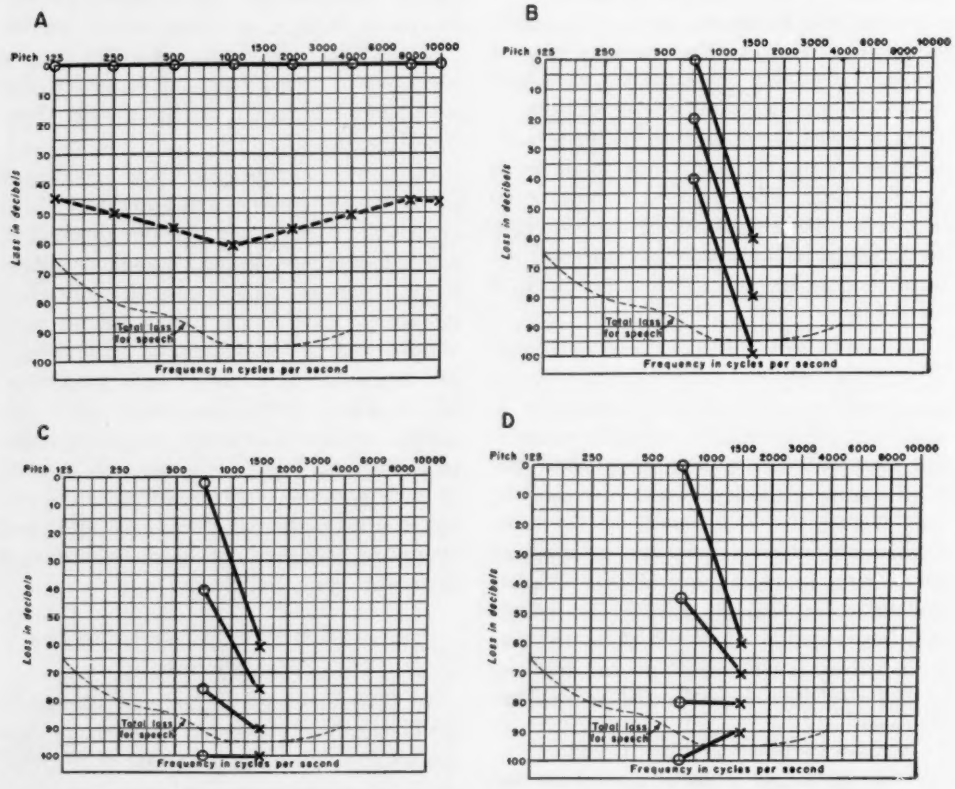

Fig. 1.—Binaural measurement of recruitment. *A*, Illustrative audiogram showing unilateral deafness. *B*, Binaural loudness balance at 1000 cps showing no recruitment. *C*, Binaural loudness balance at 1000 cps showing complete recruitment. *D*, Binaural loudness balance at 1000 cps showing overrecruitment.

defective ear for the test tone of 1000 cps. Figure 1*D*, in which the lines change from a downward slope to an upward slope, showing less intensity required in the impaired ear than in the normal ear for equal loudness, indicates overrecruitment.

THE SIMULTANEOUS BINAURAL LOUDNESS-BALANCE TEST

Bruine-Altes introduced a variation to the Fowler test in which a tone was presented simultaneously in the two ears and the intensities were adjusted so that the tone seemed just as loud in one ear as in the other. Results and interpretation of this technique were considered similar to those matched at different frequencies in a single ear at one or more levels above threshold. He found that certain persons with normal acuity for low frequencies and reduced acuity for high frequencies experienced an unusually rapid increase in loudness in the tones where impairment was greatest. Accordingly, the difference in intensities required for threshold of the various tones tended to diminish and disappear at levels above the threshold.

The procedure of the monaural loudness-balance test is similar to that of plotting equal-loudness contours. Both the technique and results may be compared with the basic work of Fletcher and Munson on equal-

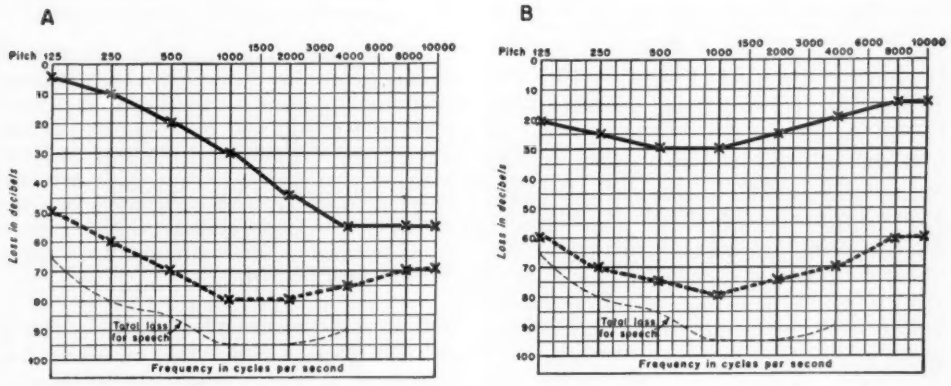

Fig. 2.—Monaural measurement of recruitment. *A*, Threshold audiogram and equal-loudness curve showing recruitment in high tones. *B*, Threshold audiogram and equal-loudness curve showing no recruitment.

of the alternate binaural loudness-balance test. However, the simultaneous method of matching loudness has not enjoyed the same utilization and confidence of other investigators as has the original technique of Fowler.

THE MONAURAL LOUDNESS-BALANCE TEST

It is apparent that if the acuity of hearing is similar in the two ears recruitment is not likely to be demonstrated by the binaural balance procedure. Reger demonstrated recruitment in patients with bilateral deafness for high frequencies by using a monaural loudness-balance test in which loudness is loudness values in normal ears. A tone of 1000 cps is used commonly as reference at some suitable level above threshold; then each of the other audiometric tones is presented alternately with the reference tone and adjusted in intensity until the two are judged to be equally loud. The intensity levels so obtained may be plotted on an audiogram for convenient appraisal and comparison.

Figure 2 illustrates equal-loudness curves which represent monaural loudness-balance measurements at 50 db. above threshold at 1000 cps. Figure 2*B* shows the equal-loudness curves to be parallel to the thresh-

old curve and is interpreted as indicating no recruitment. Figure 2*A* shows a narrowing of the difference between threshold and the points of equal loudness in tones where impairment is greatest and is interpreted as indicating recruitment for the tones where the narrowing occurs.

ADDITIONAL MEANS OF ILLUSTRATING LOUDNESS-BALANCE VALUES

Steinberg championed the practice of measuring hearing loss for sounds above threshold rather than at threshold level on the ground that such measurement would differentiate between nerve and conductive deafness. Presumably the presence of recruitment would indicate nerve deafness and its absence would show conductive deafness.

The procedure that he suggested is essentially that of plotting an equal-loudness curve with 1000 cps at 70 db. above normal threshold used as the reference tone. All other tones then would be matched in loudness to the reference tone. The results of such a loudness matching test may be plotted on a standard audiogram chart in terms of the difference between matching intensities for the normal and those of the ear being tested. Thus an impaired ear with recruitment would show little or no intensity difference from the normal at the 70-db. level

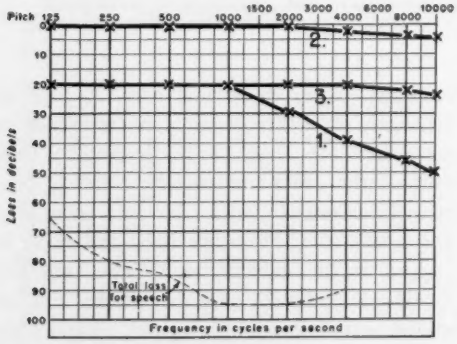

Fig. 3.—Steinberg's method of indicating recruitment. 1. Threshold audiogram, conductive or nerve deafness; 70-db. audiogram, conductive deafness. 2. Seventy-decibel audiogram, nerve deafness. 3. Seventy-decibel audiogram, part nerve and part conductive deafness. (Reproduced with permission: Steinberg, J. C.: Tr. Am. Otol. Soc. **25**:131, 1935.)

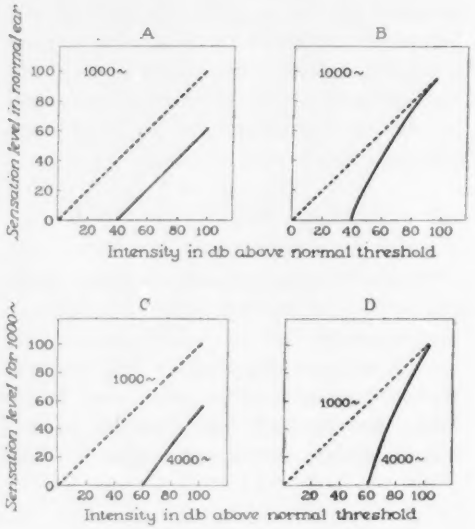

Fig. 4.—Steinberg and Gardner's method of indicating recruitment. *A*, Reduced acuity maintained at all intesities shows no recruitment. *B*, Reduced acuity at threshold with equal sensation at high intensity shows recruitment. *C*, Reduced acuity for a tone at threshold maintained at all intensities shows no recruitment. *D*, Reduced acuity for a tone at threshold with equal sensation at high intensity shows recruitment. (Modified with permission from Steinberg and Gardner.[26])

and would be plotted along the 0-db. line of the audiogram, as illustrated by Curve 2 of Figure 3. An impaired ear with no recruitment would show intensity differences from the normal in proportion to the threshold loss and would result in a curve matching the threshold curve, as shown by the lower-tone portion of Curve 3 in Figure 3. Partial recruitment is indicated by the higher-tone portion of Curve 3, where the difference in matching intensities falls between the threshold curve and the 0-db. line.

Steinberg and Gardner used still another method of graphing the results of loudness-balance tests in which a separate curve is drawn for each frequency tested. As the intensity of a tone is increased in a normal ear, the loudness increases proportionately and may be described by a 45-degree line on a chart showing intensity on the abscissa and loudness on the ordinate. A horizontal displacement of the threshold point on the

abscissa shows reduction of acuity. If the curve for an impaired ear proceeds parallel to the normal 45-degree line at succeeding levels above threshold, as in Figure 4*A*, there is no indication of recruitment. If the curve for an impaired ear approaches the normal 45-degree line at higher intensities, as in Figure 4*B*, it shows a decrease or disappearance of the difference in intensity required for equal loudness and indicates the presence of recruitment.

This type of graph also can be used for comparison of the loudness of two different tones and, hence, is suitable for illustrating the results of monaural loudness-balance as well as binaural loudness-balance measure-

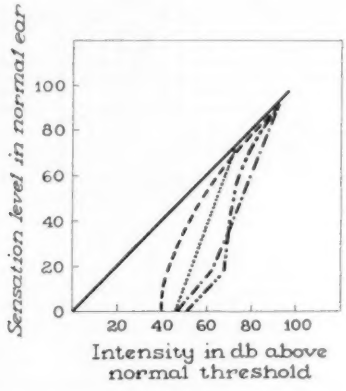

Fig. 5.—Types of recruitment curves:
1. Asymptotic - - - -
2. Straight line .....
3. Delayed - - - - -
4. Delayed plus asymptotic - - - - - - -

ments. If the acuity of hearing for a given tone is normal, the loudness function for that one may be described by a 45-degree line on a chart showing loudness as a function of intensity, as illustrated by the dotted lines in Figure 4*C* and *D*. Reduced acuity for a different tone is indicated by a horizontal displacement. If there is no recruitment for the tone showing the loss, its function will be described by a line parallel to the normal line, as indicated in Figure 4*C*. If there is recruitment for the tone that is reduced, the horizontal displacement extant at threshold will diminish, so that the two lines converge at high intensities, as shown in Figure 4*D*.

TYPES OF RECRUITMENT

Harris, Haines, and Myers used the alternate binaural loudness-balance procedure to explore recruitment in a group of 23 patients with some degree of monaural deafness. The ears under study represented a variety of types of deafness. They found considerable variation in the onset, the rate, and the degree of recruitment. On the basis of this work four types of recruitment curves were distinguished: asymptotic, straight line, delayed, and delayed plus asymptotic. These types are illustrated in the respective curves of Figure 5.

These authors offered no conclusive interpretation of the relationship between the type of recruitment curve and the type of hearing impairment. They did suggest that "quite possibly, varieties and rates of recruitment are related to whether all hair cells or nerve fibers are partially damaged, whether some are partially damaged and some destroyed, whether some are normal and some partially damaged, etc."

Certain analogues of recruitment were found in normal ears as a result of temporary impairment of acuity by fatigue or masking. Subjects who were temporarily deafened by subjection to intense sound showed straight-line or delayed recruitment, while those with acuity impaired by a masking noise exhibited asymptotic recruitment.

The over-all results of this study led the authors to conclude that recruitment may arise from any one of several sources.

THE MASKING AUDIOGRAM

In 1946, Bruine-Altes published results of an extensive study of recruitment. She applied the masking audiogram along with several other measures of recruitment to 125 patients exhibiting a wide variety of hearing impairments. On the basis of this work she considers the monaural masking method to be particularly useful in examining for recruitment in cases of symmetrical

deafness which show a normal or nearly normal threshold for at least one frequency while one or more frequencies are significantly impaired. In this procedure two tones are applied simultaneously to the same ear. The tone of lower frequency is used as a masking tone, while the higher frequency is the masked tone to be used as the test signal. Determination of recruitment by this method is based on the shift in threshold of for each of the tones to be used should be taken and recorded. The additional intensities then applied and recorded for interpretation are expressed in relation to these thresholds rather than in terms of normal threshold. For example, if the ear to be tested has a threshold of 20 db. for the masking tone, the first step in increasing the masking tone by 10 db. will be to 30 db., the second step to 40 db., and so on.

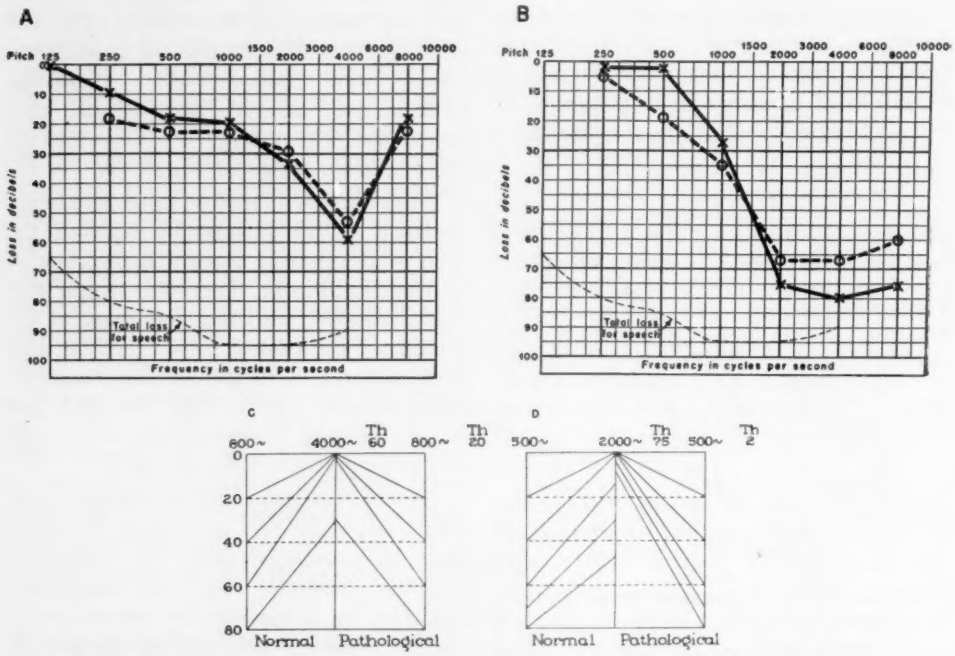

Fig. 6.—Comparison of the shift in threshold due to masking in a normal and in a test ear. *A* and *B*, Threshold audiograms: X----X, air conduction; o- - - -o, bone conduction. *C*, Masking audiogram showing normal relationship between 800-cps and 4000-cps tones. Indicates no recruitment. *D*, Masking audiogram showing abnormal relationship between 500-cps and 2000-cps tones. Indicates recruitment for 2000-cps tone. (Modified from Bruine-Altes.[3])

the masked tone as the intensity of the masking tone is increased. In the absence of recruitment the threshold shift is expected to be similar to that of normal ears. If recruitment is present, the threshold shift due to masking should be distinctly less than normal. Administration of this test requires two pure-tone generators with separately controlled signals which can be delivered simultaneously to a single earphone. The unmasked threshold of the ear under test

After each increase in the masking tone the masked tone is brought from below audibility to the intensity level at which the subject reports hearing it emerge through the masking tone. This point is noted and recorded as so many decibels of threshold shift above the subject's unmasked threshold for that tone.

Figure 6 shows the usual type of graph used for comparing the shift in threshold due to masking in a normal ear and in a

test ear. In Figure 6*C* and *D* the mean threshold shifts for normal ears, according to Bruine-Altes, are shown on the left, while those for the test ear are indicated on the right of each chart. The bunching of lines in Figure 6*D* indicates relatively little shift in masked threshold for this ear and is interpreted as showing recruitment for the masked tone. In Figure 6*C* the lines for the test ear show approximately the same threshold shift as those of the normal ear and are interpreted as showing no recruitment.

THE LÜSCHER-ZWISLOCKI TECHNIQUE

In 1949 Lüscher and Zwislocki published the results of their work using amplitude modulation as a measure of the intensive DL. Their technique and results on normal ears compare closely with the earlier work of Riesz on normal differential sensitivity to changes in intensity. For clinical purposes they recommended the determination of DL at 40 db. above threshold of the ear under examination. This was done by introducing intensity modulation that could be increased

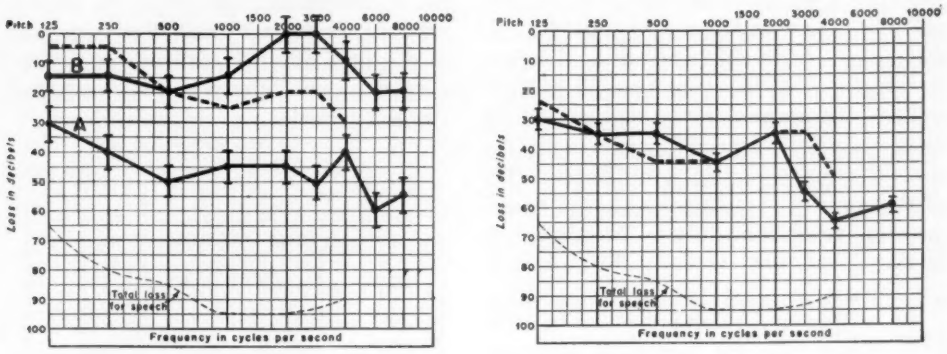

Fig. 7.—The difference limen in the presence and absence of recruitment. Left: Audiogram with indication of normal DL before (*A*) and after (*B*) treatment. Right: Audiogram with indication of abnormally small DL. (Modified from Lüscher and Zwislocki.[19])

THE DIFFERENCE LIMEN FOR INTENSITY

The measurement and study of difference limen (DL) of intensity have been employed by a number of investigators in attempts to identify recruitment on a monaural basis. It has been observed that ears with recruitment usually have abnormally small margins of discrimination for intensity changes. At levels near threshold a normal ear is likely to require a change of 2 to 4 db. to be recognizable, while an ear with recruitment may detect a change of as little as 0.5 db. In normal ears the DL becomes smaller as the intensity of the measuring tone increases to 40 or 50 db. above threshold. In ears with recruitment the DL tends to remain the same or to change significantly less than in normal ears as intensity is increased. Observation of these phenomena has led to several techniques of testing.

or decreased until the listener could just detect the fluctuation or pulsing effect in the tone. The amount of modulation was computed in the percentage change of sound pressures. According to their interpretation, the DL for normal ears would lie between 10% and 16% pressure modulation, ears with partial recruitment would give a DL of 6% to 8% change in pressure, and complete recruitment would be indicated by a DL of less than 6% modulation. Converted into decibel values these data would place the normal DL at a 40-db. sensation level between 0.9 and 1.5 db. and the DL of ears with complete recruitment at a point below 0.54 db.

Graphic illustration of the DL in the presence and absence of recruitment is presented in Figure 7.

THE DENES-NAUNTON TECHNIQUE

Denes and Naunton observed that there were wide individual differences which made it extremely difficult to interpret the DL obtained at a single intensity. In an attempt to overcome this difficulty they measured the DL at 4, 24, and 44 db. above threshold and made comparisons of the changes in DL as intensity was changed. Their technique of stimulation differed from that used by Lüscher and Zwislocki also. Instead of applying intensity modulation to a single tone, they presented alternately two discrete tones of slightly different intensity and determined the least difference that could be distinguished. In this technique the difference in amplitude of the two tones is reduced until the listener reports that they are equally loud, then it is increased again until the listener reports hearing a difference. This procedure may be repeated as often as necessary for reliability and may be applied at any level and to any tone that the equipment produces.

By comparing the shift in DL as a function of intensity with the results on loudness-balance tests, Denes and Naunton concluded that in ears without recruitment the DL becomes smaller as intensity is increased, while in ears with recruitment it tends to increase or remain constant with increased intensity.

THE JERGER TECHNIQUE

In 1952, Jerger [17] proposed a clinical test of recruitment based on a modification of the Lüscher-Zwislocki technique. In this test the DL is measured at 15 db. instead of 40 db. above threshold and the modulation of the tone is introduced gradually rather than abruptly, as in the earlier test.

A year later Jerger [18] modified his procedure to incorporate what he considers the best features of both the Lüscher-Zwislocki and the Denes-Naunton techniques. Following the principles established by Denes and Naunton and the essential technique of Lüscher and Zwislocki, he measured the DL at 10 db. and again at 40 db. above threshold. By subtracting the DL obtained at 40 db. from that obtained at 10 db. the difference in DL is computed. These data may be plotted on a chart similar to an audiogram for convenient appraisal.

If the curve representing the difference in DL for a particular ear lies below the range that represents normal difference, the fact is interpreted as showing recruitment. The shaded areas of Figure 8 represent the range of DL difference for normal ears at the 10-db. and 40-db. levels. These data were compiled and standardized by Jerger using measurements from 24 normal ears. Statistically there proved to be a 95% chance that the DL difference at 10 and 40 db. for normal ears would fall within the range indicated. Ears with recruitment are expected to exhibit a DL difference of less magnitude than the normal.

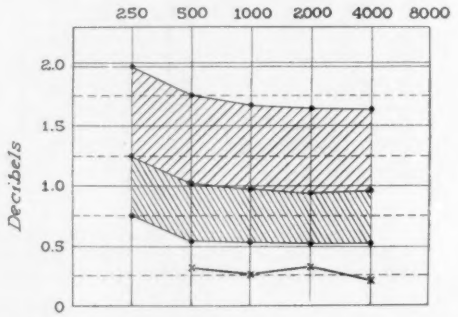

Fig. 8.—Difference of DL at 10 db. and at 40 db. Shaded area represents normal range. X----X: Lowered difference of DL shows recruitment. (Modified with permission from Jerger.[18])

OBJECTIONS TO DL TECHNIQUES

A recent article by Hirsch, Palva, and Goodman throws doubt on the validity of the DL as a measure of recruitment. They, like Mygind and Williams, raised theoretical objections to the assumed identity of lowered DL and recruitment. These objections are supported by an experimental study that compares results obtained by speech tests, loudness-balance tests, and DL for intensity.

The technique used for measuring DL was essentially the Denes-Naunton procedure. The loudness-balance tests employed were essentially the standard binaural and monaural techniques of Fowler and Reger, respectively. Hearing for speech was measured

with the CID auditory tests W-2 and with the Harvard PB word lists. Subjects for the study included 44 patients with a variety of types of hearing loss and 18 persons with normal hearing.

Results indicated that the DL as measured here cannot be relied on to distinguish between ears with and without recruitment or between defective and normal ears.

THE BÉKÉSY AUDIOGRAM

The pure-tone audiogram as determined by the Békésy [1] technique provides a type of measure of intensity discrimination at threshold and thus is closely related to the difference limen for intensity. According to Békésy,[2] when recruitment is present the changes in sound intensity that can just be perceived are smaller than normal, that is, the difference limen for intensity is diminished. This test is self-administered in the sense that the subject undergoing examination controls the increase and decrease of intensity by pressing a switch. In the Békésy type of audiometer an electric motor varies the frequency continuously, so that the range of tones to be tested is run through from the lowest to the highest in approximately 20 minutes. The intensity of the sound also is regulated by an electric motor which is controlled by the patient. The test is started with the intensity of the signal below the person's threshold. The patient presses a button, thereby increasing the intensity until he hears the tone; then he releases the button, allowing an automatic decrease of intensity. When the tone is no longer heard he presses the button again until it reappears. This process is continued through the entire range of tones produced by the instrument. A graph of these variations is traced on paper by a stylus. The audiogram thus obtained appears as a jagged line fluctuating in just-audible steps above and below threshold. The width of the band within which the jagged line lies indicates the degree of sensitivity for change of intensity at threshold. For persons with normal hearing and for those with impaired hearing without recruitment the variations are expected to be from 15 to 20 db., as illustrated in Figure 9*A*. When recruitment is present, the fluctuations of the jagged line are expected to be significantly smaller than when recruitment is absent, as illustrated in Figure 9*B*.

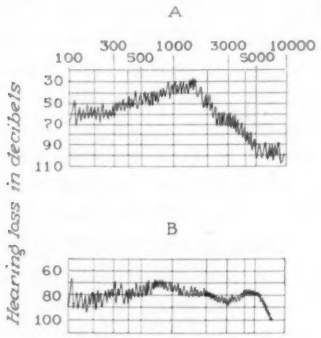

Fig. 9.—Békésy audiometric curves showing (*A*) absence of recruitment and (*B*) presence of recruitment. (Modified from Békésy.[1])

TESTS FOR AUDITORY FATIGUE AND MASKING

Tests of auditory fatigue have been found to bear a relationship to recruitment. Békésy [2] stated that "by fatiguing a normal ear one can very easily produce deafness which shows the recruitment phenomenon." In studying the effect of exposure to loud tones and noises on normal ears, Davis and associates found that in ears in which a temporary impairment was induced by fatigue there was always some degree of recruitment. This recruitment was not always complete, and frequently there was a delay in its onset. They also found instances of overrecruitment, in which the ear that was fatigued heard a test tone louder than did the unexposed ear. A point of interest in this study is the considerable variability in the way in which the loudness function was affected by auditory fatigue. This result is interesting in comparison with that of Steinberg and Gardner, in which masking the ear with thermal noise produced a uniform degree and type of recruitment. Harris, Haines, and Myers also expressed the belief that ears temporarily impaired by fatigue always experience re-

cruitment and that probably it is complete, but that for slight degrees of impairment the recruitment may not be apparent near threshold.

Huizing [15] demonstrated a definite relationship between pathologic recruitments and reversible auditory fatigue by comparing the shifts in threshold resulting from exposure to sound in a group of subjects representing normal hearing and a variety of hearing disorders. Although the ears with impairment represented different types of deafness, the degree of loss was similar in all of the test cases. He found a significantly greater shift in threshold for ears with recruitment than for normal ears or impaired ears without recruitment. Each ear used in the investigation was exposed to a tone of 2000 cps at 30 db. above its individual threshold for a period of three minutes. Threshold measurements for a tone 2000 cps taken before and after the exposure revealed the shift in threshold attributable to fatigue. In normal ears and impaired ears without recruitment the maximal shift was 12 db., while in ears with recruitment the shift was from 19 to 22 db.

This procedure is proposed as a clinical test to aid in diagnosis and in application of therapeutic measures. It has the practical features of being simple and relatively short, and for most ears it imposes no discomfort.

TESTS OF SPEECH RECEPTION

It has long been recognized that tests of speech reception may reveal information of diagnostic value to the otologist. In 1890 Habermann reported observing an unusually abrupt onset of loudness for spoken voice in the ears of boiler makers who had suffered impairment of threshold for whispered voice. In 1912 Gradenigo proposed the index vocalis as an expression of the relative distances at which whispered speech and spoken voice were audible. In 1933 Pohlman and Vermillion reported that for certain types of deafness an increase in loudness of speech does not result in the expected increase in intelligibility. Recent methods of testing for reception of speech with instrumentally controlled signals have demonstrated a strong relationship between auditory recruitment and certain types of speech measurements. The findings of Dix and Hallpike and of Eby and Williams are particularly pertinent to this point.

The simplest of these measurements and the one that corresponds most nearly to earlier methods is determination of the intensity span between threshold of intelligibility for speech and the comfort level for listening to speech. For normal ears this range usually approximates 50 db. The range for ears with moderate loss of acuity without recruitment is likely to be in the neighborhood of 30 db. In ears with marked recruitment it frequently is narrowed to as little as 10 or 15 db. Another related measurement is the intensity span between the level for comfortable listening and the level at which a signal becomes painful or tickles the ear. For normal ears and moderately impaired ears without recruitment this again is usually a relatively wide range of 50 db. or more. In ears with recruitment it is likely to be narrowed decisively. It follows that the total range from threshold of intelligibility to the level of pain has significance in detection of recruitment.

A suitable and convenient method for determining these levels of speech intensity is the use of familiar spondaic words delivered through binaural headphones from an amplifying system in which intensity is controlled in decibel units. Threshold for speech usually is defined as the level at which 50% of spondaic words can be repeated correctly. Comfortable loudness and level of pain are based on subjective judgment and report of such by the listener.

DISCRIMINATION FOR SPEECH

Tests for speech discrimination at levels above threshold also are useful in determining the presence of recruitment. These tests are based on the relationship between the intensity of the signal and the percentage of the material that is heard correctly. Results usually are plotted on a graph, with the vertical axis representing the percentage of material heard correctly and the horizontal axis representing the intensity of the signal.

Figure 10 shows typical curves of speech discrimination for normal ears and for impaired ears with different types of deafness.

It may be noted that persons with normal hearing as well as those with conductive and mixed deafness understand a relatively high percentage of the speech presented at a comfortable loudness. It is evident also that as intensity is increased above the comfortable level for this group of listeners the ability to distinguish words is maintained and even tends to increase with added loudness. In contrast to this, the discrimination curve for persons with end-organ deafness shows poor understanding of words even at the optimal intensity, and as intensity is increased beyond

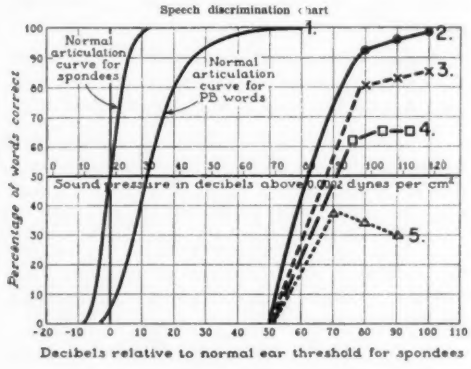

Fig. 10.—Curves of speech discrimination: 1, normal hearing; 2, conductive deafness; 3, mixed deafness; 4, nerve deafness; 5, end-organ deafness.

this level the ability to distinguish words decreases further. While this situation may obtain for any type of deafness that is extremely severe, it is felt that its occurrence in cases of moderate and moderately severe deafness is an indication of recruitment.

In this connection Huizing [16] stated that "in cases of severe perception deafness with strong recruitment the intelligibility factor will drop down to a very low value and it is conceivable that such people cannot be helped with a hearing aid by merely amplifying speech sounds."

Eby and Williams found that, while there was variability in the power to discriminate speech among their cases with nerve-fiber deafness, this function was significantly better for the group with nerve lesions than for those with end-organ deafness of similar degree. They noted too that in most cases with nerve-fiber deafness the discrimination of speech increased as intensity of the signal was increased above the comfortable level, while in end-organ deafness the intelligibility of speech decreased at levels above that of comfortable loudness. The recent work of Hirsch, Palva, and Goodman also supports the contention that poor discrimination for speech is associated with recruitment.

The most commonly used material for speech discrimination testing is the monosyllabic phonetically balanced (PB) words which were compiled by Egan at the Harvard Psychoacoustic Laboratory. These words are arranged in multiple lists of 50 words each, with each list equated as closely as possible in phonetic content and intelligibility to every other list. This makes it possible to do repeated tests on a single subject without introducing the factor of memory. The words used for these lists were selected for their simplicity and common usage and were grouped so that each list is representative of the speech elements that occur in everyday speech.

The PB word-discrimination test may be given either from phonograph recordings through a suitable amplifier and control system or by live voice through the speech circuit of an audiometer or other appropriate sound system. The subject being tested is asked either to say or to write the word that he hears or thinks he hears. A percentage score is readily determined by allowing 2% for each word of a 50-word list that is repeated correctly. Ordinarily, discrimination scores are obtained at two or more intensities near the person's level of comfortable listening.

In order for the comparison of discrimination scores to be meaningful, it is imperative that the quality of the speech signal and the environmental conditions be held as constant as possible.

Like other tests of auditory function, and for that matter most clinical evaluations, the results obtained by tests of speech discrimination are often only relative and must be judged in the light of other findings. Nevertheless, this type of test provides valuable information for both diagnostic and therapeutic consideration. It has proved to be uniquely suited for evaluating minor changes in hearing function that may occur spontaneously or as a result of treatment. It is not uncommon to find that in the course of treatment for Ménière's disease the threshold audiogram will remain essentially stationary while the patient experiences subjective improvement in hearing. Such improvement or the reverse of it usually can be substantiated and quantified by speech-discrimination scores.

SUMMARY

In summary, the tests that are advocated for the measurement of auditory recruitment may be grouped into four general types:

1. Tests that compare and match the loudness of sounds
2. Tests of the difference limen for intensity
3. Tests of auditory fatigue and masking
4. Tests of speech reception and discrimination

The several techniques of applying each type of test are described along with the results and rationale that led the respective investigators to utilize a particular method. On the basis of the literature and experimentation reviewed and also from reports of clinical practice it appears that each of the procedures described has some diagnostic value. Although it may be debated whether or not the various tests all measure the same auditory phenomenon, many of the authors on the subject believe there to be a close relationship in the several manifestations of abnormal sensitivity. It is clear that certain tests are more useful for some conditions, while another test may reveal more under different circumstances. With the variety of techniques available it usually is possible to determine with reasonable accuracy the relative sensitivity and loudness function of a given ear as compared with that of normal ears. Much remains, however, for the complete understanding of the underlying organic basis and, hence, of the entire clinical significance of auditory recruitment.

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Case Reports

AMYLOIDOSIS

Report of an Unusual Case

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AMYLOIDOSIS is a condition where there is deposition of a hyaline-like substance, apparently of protein nature but reacting like starch to iodine and sulfuric acid. It commonly involves the mesodermal tissues. It is seen grossly as a structureless translucent material which transmits the color of the underlying tissue and microscopically as a hyaline substance which accumulates between parenchymatous cells and in the connective tissue.

We are reporting a case because of the unusually localized tumor-like nodule found at the base of the tongue. This is in contrast to the usual diffuse nature of amyloidosis, which gives the tongue a uniform enlargement. There is difficulty in the differential diagnosis from other granuloma-like lesions.

Four varieties of amyloidosis are commonly recognized, according to the classification first proposed by Reimann, Koucky, and Eklund.[1]

1. Secondary amyloidosis is the commonest form and is associated with long-standing infections of destructive nature, such as tuberculosis, osteomyelitis, etc. In contrast to the primary type, this commonly affects parenchymatous organs.

2. Primary amyloidosis occurs in the absence of known preceding or predisposing disease and tends to involve tissues of mesenchymal origin.

3. Localized amyloidosis forming tumor-like nodules, seen in the larynx, vocal cords, tongue (usually along with other organs), pharynx, thyroid, etc. It is primary without recognizable preceding causative disease. Apparently such lesions are not uncommon, except that few have been reported involving the tongue.

4. Amyloidosis associated with multiple myeloma occurs in about 7% of cases. The distribution is similar to that of the primary type.

REPORT OF CASE

Mrs. F. K., a white married woman, 61 years of age, complained of a lump in her throat in February, 1954, stating that she had noticed some swelling of the tongue for the past year. There was some respiratory difficulty at night and a taste of "sharp pepper" on the tongue. There were varied complaints of pains and "sinus" and a definite cancerphobia. Her past history revealed diphtheria, 1897; tonsillectomy, 1926; hysterectomy, 1939; cholecystectomy, 1949. X-rays of the sinuses taken in March, 1953, showed osteomata of the left side involving frontal sinus and on the right side involving anterior ethmoid cells.

Her first visit to the office (E. P. C.) for the "lump in her throat" revealed the presence of a small cyst of the right epiglottis, near the tip, and a barely noticeable lesion which appeared to be hypertrophied lingual tonsil at the left base of the tongue. Physical examination in the hospital showed a slightly enlarged heart and blood pressure of 182/95. The liver, spleen, and kidneys were not palpable.

The cyst of the epiglottis was removed and a biopsy specimen was taken from the base of the tongue at the Hospital of St. Barnabas and for Women and Children Feb. 24, 1954. The pathologist (W. G. B.) reported the presence of some polypoid thickening of the squamous epithelium composing

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the mucous membrane, which otherwise appeared uniform and regular. There was no malignant change noted, and it would appear that the biopsy specimen consisted mostly of superficial mucous membrane with little stroma.

On March 2, the patient was again examined by one of us (E. P. C.) in the office and a mass protruding from the left base of the tongue (site of previous biopsy) was noted to be quite prominent, about 6 to 7 mm. above the mucosa. On March 8, in view of an unsatisfactory previous biopsy, it was decided to remove a larger specimen as an office procedure. This was done with a tonsil grasp and tonsil snare, leaving the contour of the base of the tongue normal.

The pathological report was as follows: "Sections show an extensive granulomatous reaction with no identifiable normal muscle tissue present. Within this granuloma are closely packed round to oval and slightly irregular hyaline bodies, variable in size, surrounded by a thin connective tissue wall. The intervening tissue is hyperaemic and densely infiltrated by lymphocytes, plasma cells, and giant cells of the foreign body type. Several of these giant cells contain asteroid inclusion bodies. These hyaline bodies may represent either (1) degenerated hyalinized muscle, or (2) complete hyalinization of sarcoid tubercles with para-amyloid degeneration, or (3) collections of amyloid. Diagnosis: Sarcoid-like granuloma."

Fig. 1.—Low-power picture of fairly well-circumscribed tumor-like nodule within muscle of tongue. There is lingual tonsillar tissue on the left and cartilage of epiglottis and mucous glands on the right. Bennhold's Congo red stain; reduced ⅙ from mag. × 7.

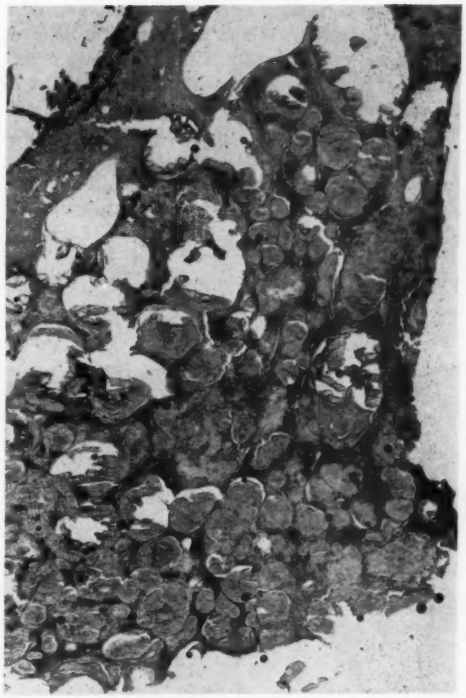

Fig. 2.—Slightly higher magnification of homogeneous hyaline bodies in tumor-like nodule. Methylrosaniline chloride stain; reduced ⅙ from mag. × 11.

Because of the preliminary diagnosis of sarcoid-like granuloma by one of us (W. G. B.), the patient was referred back to her family physician for complete reevaluation of her general status. The physical examination was within normal limits and chest x-rays were negative.

On May 13, 1954 (only two months later), the patient returned (E. P. C.) for examination. The mass at the base of the tongue was observed with a laryngeal mirror to be nearly 1 cm. in diameter, protruding backward, pushing the epiglottis back so that the intrinsic larynx could no longer be viewed. The tumor was limited to the left side and resembled in outline the terminal phalanx of a finger in a sharply limited area of the left base of the tongue. The absence of sarcoidosis elsewhere in the body and the rapid increase in the size of the sharply limited local lesion seemed sufficient indi-

cation for its radical removal. On June 8, 1954, through a suprahyoid pharyngotomy, the base of the tongue was exposed and the mass with a surrounding centimeter of normal tongue and part of the epiglottis was removed. The pathological examination of the specimen removed at this time was similar to that of the previous one. Special stains for amyloid done at this time were positive in this as well as in the previous specimen. Methylrosaniline chloride (crystal violet), Congo red, McManus (counterstain with fuchsin), Van Gieson, and toluidine blue stains were used, and all were found positive for amyloid. The Hass method of extrac-

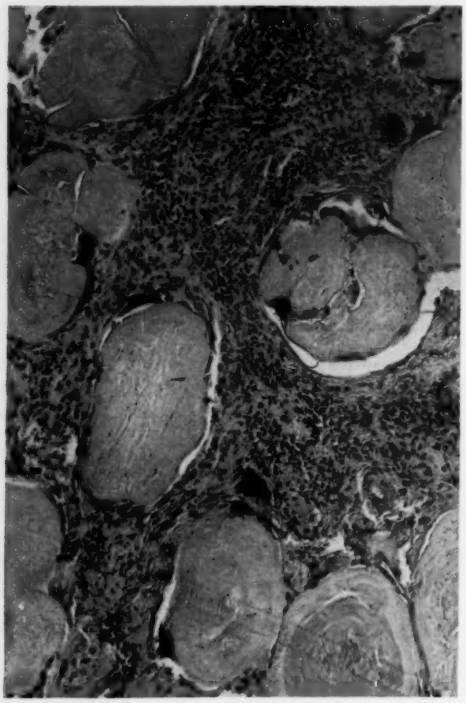

Fig. 3.—Higher magnification of varied-sized ovoid bodies of homogeneous amyloid-containing material. They appear to be within a space and some have a suggestion of being concentrically lamellated. Hematoxylin and eosin stain; reduced ⅓ from mag. × 75.

tion and in vitro analysis was not used in this case. The pathologist's (W. G. B.) report was as follows: "The specimen is an irregular piece of brownish gray tissue, measuring approximately 2.5 cm. in diameter. On cut section, there is in the midst of the specimen a nodular mass measuring 1.5 cm. in diameter which is yellowish-gray in color and firm in consistency. To one side of the specimen is brownish red muscle tissue and on the other side is a piece of tissue resembling cartilage. [Fig. 1].

"On microscopic section, mucous membrane, mucous glands, cartilage, tonsillar tissue and tongue muscle are found. Within the muscle of the tongue is a large, fairly well circumscribed area, appearing fibrotic with varying areas of cellularity. However, on higher magnification, fibrocytes are not abundant. Within this connective tissue matrix are varying sized ovoid to round collections of homogeneous material which seem to be within a space having a narrow, clear zone separating them from the adjacent stroma. [Fig. 2]. Many of these homogeneous hyaline bodies have a suggestion of being concentrically lamellated. Between them are numerous giant cells of the foreign body type and a few scattered inflammatory cells. [Fig. 3]. There is also a moderate amount of vascularity present throughout the fibrous matrix. These sections are similar to those described before on this patient on March 8, 1954. Subsequent special stains on the latter biopsy were also positive for amyloid.
"Diagnosis: Primary amyloidosis (localized) of the tongue."

When seen on her last visit to the office, over a year later, the wound had completely healed and the patient had no evidence of residual disease. Two black nonabsorbable surgical (silk) sutures were still present in the base of the tongue, and the entrance to the upper larynx was somewhat narrowed. There was no evidence of epiglottis remaining. There was no impairment of speech or swallowing function.

COMMENT

In the third group under the classification, that is, localized amyloidosis forming tumor-like nodules, the difficulty is in proving that amyloid deposits are not present elsewhere in the body, and it is always possible that some of these supposedly localized cases represent generalized amyloidosis of the systemic nonparenchymatous type. In this case, all known tests have been done to rule out systemic nonparenchymatous amyloidosis but the possibility still remains, and only time will tell the final story.

Amyloid disease of the tongue is usually a diffuse, so-called macroglossia accompanying systemic amyloid disease. Local infiltrations of the tongue can consist of waxy papules, blisters, or, more rarely, nodules or plaques. The lesions can be found in the dorsum, lateral margins, or undersurface and on the frenulum.

In view of the variations in staining reactions from case to case, and even from organ to organ, it is unsafe to draw far-reaching conclusions after studying only one case. For that reason several special staining methods for amyloid were used here. Despite the variability of the results of special stains, it is felt that at least some positive reaction to Schiff's reagent is confirmation of the presence of polysaccharide in the amyloid. Neither the McManus nor the methylrosaniline chloride stain is specific for amyloid, but, according to R. W. Goltz,[3] the former is the more useful staining method. All known staining methods were used in both the biopsy and the resected specimen, and all were found positive. The staining techniques used were methylrosaniline chloride, Congo red, McManus (periodic acid-leucofuchsin stain), Van Gieson, and toluidine blue stains.

SUMMARY

This case is recorded, as it was considered unusual. A review of the literature concerning this subject reveals that amyloidosis seen affecting the tongue is usually generalized, giving the tongue a uniform or slightly nodular enlargement, in contrast to the rapidly growing tumor-like character in this case.

D. Brachetto-Brian and associates report a solitary amyloid tumor of the femur without generalized amyloidosis.[4]

In the field of otorhinolaryngology amyloidosis classified under the localized or tumor-forming type is rare, and an exhaustive review of the literature shows a few cases, in the larynx, in the vocal cords, and in the trachea.[10]

Special staining of the histologic sections and photography by Dr. Edwin O. Gilbert and Bernhardt V. Lind, of The Bureau of Pathology, New Jersey State Department of Health.

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Progress in Otolaryngology

THE PARANASAL SINUSES

Summaries of the Bibliographic Material Available in the Field of Otolaryngology for 1953

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ANATOMY, PHYSIOLOGY, PATHOLOGY, X-RAY DIAGNOSIS

STOKSTED* has been conducting experiments and investigations in the field of nasal physiology and contributes two articles dealing with nasal respiration. In the first one he presents the results in a series of tests for the determination of air resistance in the nasal chambers in 100 normal subjects. The measurements were made with a manograph, a sensitive manometer, the oscillations of which "are transferred to a calibrated roll of paper moving at a constant rate by means of an electric clock synchronizer." The manometer is connected to a nasal plug fitting snugly into one nostril, the subject breathing through the opposite free nostril. After a dozen or more respirations the plug is then transferred to the other nostril and the same procedure is carried out. Thus the pressure variations in the nasopharynx are transmitted through the tube connected with the closed nostril and recorded on the revolving drum. To make the results authentic it is important that all tests be conducted under the same conditions of room temperature and humidity.

The results of his measurements in the 100 subjects averaged 18 mm. H_2O per second, with variations between 11.4 and 27 mm. "The resistance in the two nasal cavities shows constant deflections synchronous with the nasal cycle, while the resistance in the nose as a whole keeps at a constant level."

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* References 1 and 2.

The investigations reported in the second paper have to do with the determination of the nasal cycle, in which the nasal chambers vary in dimension alternately as the tissues respond to nerve impulses from the autonomic system. According to the best information to date, it appears that the peripheral regulation of the cycle takes place through the stellate ganglion and the sphenopalatine ganglion, the latter causing contraction and the former expansion of the conchal mucosa. It is probable that the action of the two is coordinated by impulses from the central sympathetic center, possibly located in the hypothalamus. This organ is affected by impulses from the respiratory centers and is also affected by peripheral impulses set in motion by changes in temperature and humidity.

Analysis of the cyclic curves shows good agreement with that of the rhinoscopic findings. In some cases, however, where nasal pathology affects the direction of the air currents, it has been found that the rhinometric determinations will give a better estimate of the functional capacity of the nasal passage than can be gained from the rhinologic inspection. It is much more accurate than the patient's estimate of his nasal respiration because most patients are poor observers of their own symptoms. This applies especially to children.

A number of typical curves are shown in normal persons as well as a few taken in persons with anatomic differences in the two sides.

In a third contribution by Stoksted, in collaboration with Thomsen,[3] it is shown that in experimental stellate block nasal resistance on the affected side is greatly

increased, while the contralateral side is but little affected. The procedure of measuring the air resistance was described in the article above.

Tremble [4] has continued his studies of ciliary activity under the phase contrast microscope, confirming some previously observed phenomena and adding some fresh data. What gives the cilium its impetus or regulates its stroke is still an unsolved problem. An interesting theory on this point is the one involving the function of the centrosome, or "central body," of the cell, which appears to be multiple in the form of basal granules that are found in the distal portion of the cell. When the cilia are stripped off they cease to beat. Observations of ciliary motility may be facilitated by slowing the beat through increasing the viscosity of the solution or adding a little cocaine solution. Reducing the pH restores their normal activity. Since the pH is found to be high during the early stages of acute rhinitis, it follows that measures designed to bring it down to a normal pH of 5 or 6 will increase the effectiveness of the cilia in combating the infection.

Suarez [5] discusses the various theories that have been advanced to explain the function of the paranasal sinuses. He also cites a number of authors who have measured the variations in air pressure in the nose, nasopharynx, and antrum during the respiratory cycle. He comes to the conclusion that their function is to regulate the pressure within safe bounds and to mitigate the high pressures which accompany such acts as sneezing, nose blowing, etc. He claims that in cases where the sinuses are absent or occluded by disease or new growth the variations in pressure are much wider and less controlled than in the normal.

Bertolotti's [6] studies concern the combination of roentgen and clinical findings in morphologic anomalies of the craniofacial sinuses. He states that the ethmoid labyrinth is the keystone, whose development and pathologic states influence the development of the entire craniofacial base. Isolated foci of infection, clinically undetected, may act as insidious foci of inflammation affecting the adjacent basal tissues. Pathologic metopism may result, presenting a symptom complex, which he divides into two groups of symptoms.

The radiographic findings consist of the following:

(*a*) Brachycephalia

(*b*) Increase in the intercarunclar diameter, with persistence of infantile type of orbit

(*c*) Agenesis of the frontal sinuses and hypoinvolution of the facial bones

(*d*) Incomplete ossification of the median frontal suture

(*e*) Parasutural sclerosis

(*f*) Condensation of the diploetic tissues, presenting a ground-glass picture in the inferior medial frontal areas

(*g*) Frequent findings of small foramina and canaliculi, indicating the presence of new-formed vessels

(*h*) Central opacity, with cloudy halo about the crista galli

(i) Radiographic signs of increased cerebral fluid pressure.

The clinical signs are the following:

(*a*) Intense frontal headaches beginning early in childhood and developing into ophthalmic hemicrania

(*b*) Frequently local tenderness

(*c*) Adenoid facies, ocular exorbita hypertelorism

(*d*) Constant evidence of otopharyngeal inflammation, hypertrophied tonsils and adenoids, asthmatic crises, etc.

(*e*) Hydrocephalic meningismus

(*f*) Possible neurologic manifestations of disturbed pituitary function

(*g*) Convulsive or epileptic seizures

Thus the clinical results of this pathologic metopism consist of a triad of hydrocephalic meningismus, hypoevolution of the facial mass, and hypertrophy of the adenoids and tonsils.

The question as to the influence of prenatal meningopathies is treated very briefly as being a secondary element in the clinical picture. He feels that exogenic factors, beginning with early infection of the ethmoids,

continuing undetected over the period of early childhood, are primary in the development of the complex described above.

Bachi [7] studied the x-ray pictures of the sinuses in a series of 23 pairs of monozygote twins for evidence of conformity in size and shape. The results were compared with those of similar studies of dizygote twins. In the case of the frontal and maxillary sinuses the figures show a higher percentage of concordance in the monozygote than in the dizygote twins:

Sinuses	Monozygote Twins, %	Dizygote Twins, %
Frontal	61	56
Maxillary	70	62

The sphenoid sinuses, however, showed fewer differences between the two types of twins; in fact, the percentage of concordance was as low as 17% and 19%, respectively. Nevertheless, a high percentage of concordance in both types would signify the strong influence of the genetic mechanism in determining the shape and size of the sinuses. Discordance in these measurements must be attributed to stimulating and inhibitive factors.

Hass,[8] who had previously reported alteration of the frontal sinus walls in 35% of a group of patients irradiated for carcinoma in other portions of the head, now finds similar changes in the sphenoid in 20 patients with carcinoma: 12 affecting the sinuses, 3 the oropharynx, and 5 the nasopharynx. Among the 12 cases of paranasal sinus cancer with evidence of this alteration in the sphenoid walls, 11 affected the frontal sinuses similarly. The changes observed in the x-ray pictures consisted of blurring, demineralization of condensation of the bone. This gives the impression of a "low grade secondary osteitis due to occlusion and infection caused by the tumor."

A number of very fine x-ray pictures bring out the salient points of the presentation. It is important that these alterations be carefully studied so as to differentiate them from secondary involvement by the tumor itself. The chief point in differentiation is the fact that neoplastic invasion progresses at a much more rapid pace than the secondary osteitis described above.

Semenov [9] presents an extensive analysis of pathologic findings in rhinitis and sinusitis, with their complications, as part of an overall discussion of their relationship to allergy. This embraces a study of the cytology of secretions obtained under varying conditions and the histology of the tissues. These are separately discussed under the headings of catarrhal inflammation, suppurative inflammation, postnasal drip, sinusitis of various etiology, intracranial complications, osteomyelitis, suppurative and allergic rhinitis combined, sinusitis and asthmatic complication, postoperative scar tissue, concha bullosa, ozena, rhinoscleroma, and cysts.

The article is amply illustrated with photographs of histologic sections, x-ray pictures, and cytologic smears, as well as illustrative case histories. A wealth of material is packed into this monograph, which is well worth while for study and reference.

Tunevall [10] conducted a survey among 108 school children to determine the occurrence and significance of the common respiratory pathogens as well as the immunological response. The children were examined three times at intervals of two to three months, which included E. N. T. examination, x-rays, allergic study, and bacteriologic study of material removed from the sinuses via a swab passed through a sterile trocar. The bacteria commonly found included pneumococci, streptococci, influenza bacillus, and pyogenic staphylococci.

It was found that pneumococci and the influenza bacillus played a major part in the sinusitis that was so frequently discovered; 60% of the so-called normal children, apparently healthy or suffering from minor colds, presented sinus changes. In 30% the changes were pronounced, and in 30% the cultures yielded pathogenic bacteria.

Elevated antibody reactions were more frequent among carriers of hemolytic streptococci, influenza bacillus, and pneumococci than among noncarriers. The conclusion

reached was that "the antigenic action of these bacteria upon children to a very great extent emanates from sinus processes."

The author presents a number of tables showing "Nasal carrier rates—incidences of positive serological reactions," "Incidence of bacteria and antibody titers—normal as well as pathological sinuses," "Bacteriological findings in sinus specimens," "Correspondence between nasal flora and sinus findings," and "Incidence of positive serological reactions in carriers and noncarriers."

Taunay and Dias [11] studied the bacterial flora of 45 patients with sinusitis and compared the results with those of similar studies of nasal secretions from 25 clinically normal persons. The predominant organisms in the former were Staphylococcus, Hemophilus, Pneumococcus, and Streptococcus of the viridans group. Secretions from the normal cases yielded Staphylococcus and the diphtheroids.

Sensitivity tests were done with penicillin and chloramphenicol. The latter was found to be active against Gram-positive organisms. Penicillin was effective against streptococci and pneumococci but ineffective against a large percentage of staphylococci.

Samuel [12] discusses the opaque maxillary sinus, pointing out factors which may lead to mistaken diagnosis as well as those on which reliance may be placed. Technical factors, such as faulty projection whereby the petrous bone is projected into the antrum space, overextension of the neck (particularly in young patients), inaccurate centering of the central beam, underexposure, etc., all may produce confusing shadows. From the anatomic standpoint care must be exercised in assessing opacities due to underdeveloped sinuses and inequalities in the size of the two antrums. Likewise, unusual thickness of the bony walls, bony septa in the sinus, and overlying soft-tissue thickness may produce shadows mistaken for true antrum pathology.

Coming to the differential diagnosis of allergic mucosal swelling and that due to infection, the author states that in the former the mucosa presents convexities, the degree of swelling is excessive, the turbinates are swollen, and polyp formation is often visible. In the infective states the mucosal swelling parallels the bony walls, is not markedly extensive, the turbinates are not usually swollen, and polyps are infrequent.

Opacity due to fluid may be diagnosed by taking pictures with the head in different positions, the horizontal line of the fluid changing with the varied head postures, thus differentiating from cysts of various kinds.

Opacity due to dentogenous origin may be diagnosed by intraoral films showing the defect in the alveolus or a retained root.

Opacity following radical surgery is due to scar formation, with partial obliteration of the cavity.

Opacity due to a dentigerous cyst is more homogeneous than simple allergic or infectious swelling.

Tumors may produce total opacity, but in many cases atrophy of the bony walls or erosion by the disease will furnish the clue.

All of these items are well illustrated in the article.

Faaborg-Andersen [13] shows a number of x-ray pictures of the sinuses demonstrating the value of this medium of diagnosis when properly executed and interpreted. He lays emphasis on the importance of being able to show a fluid level in the maxillary, frontal, or sphenoid, which can be done if the pictures are taken in the upright as well as in the other positions. Also the use of contrast media to outline such things as a cyst or a polyp is graphically illustrated. There is nothing new in the article, since it merely demonstrates the value of good pictures.

Schüle [14] found that in a series of 510 cases there were 29% in which the pathologic findings failed to substantiate the diagnosis of infection based on positive x-ray shadows. Shadows in the antrum mistaken for disease may be due to such factors as technical inaccuracies, subnormal size of the antrum, or increased density of the over-

lying soft tissues. These are illustrated by x-ray pictures and drawings.

One must in all cases determine that on the side of a cloudy antrum the turbinal bodies are not overly large, that the bony contours of the sinus are sharply defined, that the lining mucosa is not thickened, that the sinus is not abnormally small, that there is no asymmetry between the two sinuses, and that the overlying tissues are not unusually thickened.

Dann and his co-workers [15] show a number of illustrations and diagrams depicting their procedure for visualizing the ethmoid cells in a modification of the Rheese projection. The important point is to have the central beam pass through the tip of the anterior clinoid process and optic foramen of the dependent side. This is done by using an ethmoid localizer on the principle of the Camp localizer. With the patient prone on the table and the head in a lateral starting position, "the localizer is placed over the outer canthus of the eye with the upper line on the localizer set parallel to the ciliary border and extending to the upper lobe of the ear. The ends of the tongs are then brought parallel to the central beam by adjusting the position of the head. The central ray is then adjusted to the center of the film." This is all illustrated in a number of x-ray pictures of skulls in which the various landmarks are indicated.

This procedure proved its value in a study of 45 cases of ethmoiditis, in which the findings were correlated with clinical observations where routine projections had failed.

Chalmagne,[16] after elaborating on the anatomy and development of the frontal sinuses, offers the suggestion that iodized oil (Lipiodol) be introduced into the sinus for sharper definition of its boundaries as well as for showing the location and extent of the surrounding ethmoid cells. This is done via a small trephine opening in the floor at the internal orbital angle.

Discussing aplasia of the frontal sinus, he reports having found 12 cases of bilateral and 22 cases of unilateral aplasia in a series of 420 radiographs. The pathogenesis of this condition may be a genetic factor, a postinflammatory inhibition of the normal pneumatization, or a chronic obliterating osteitis. At any rate, he claims that the condition gives rise to symptoms which have been noted by others. These are frontal headaches radiating to the nose or temporal area and a sensation of dullness or weight, aggravated by cold, fatigue, menstruation, and trauma. It is assumed that the block of dense bone acts as a site of irritation affecting the neurovegetative system. It is suggested that when relief cannot otherwise be obtained the area be trephined, excess bone removed, and an attempt made to create a cavity communicating with the ethmoids. He quotes Rebattu, who has written on this subject previously.

Del Bo [17] investigated the frontal sinuses in 11 pairs of monozygotic twins, aged 14 to 28, and found marked similarity in form and volume. However, in several cases, x-ray pictures of which are shown, it was evident that in one of each pair the sinuses had not developed to the same degree as in the other. In these instances there was a history of repeated nasal infection requiring surgery. The author therefore concludes that, although the hereditary factor was strong enough to develop the sinuses similarly, exogenous factors, such as infection, contracted early in life can exert an inhibitory effect.

Carini [18] finds laminography very useful in determining the status of the sinus mucosa as well as the intranasal structures. He uses a voltage of 80 kv. and a rather long exposure (5 seconds). A 30 by 30 cm. film is divided into four quadrants 13 by 13 cm., so that the exposures can be viewed on the one film. The motion of tube and plate is in the caudocranial plane. The four exposures are spaced so as to show in succession the frontal sinus, the maxillary antrum at its maximum width, the ethmoids, and the sphenoids. The pictures shown are very convincing.

Leiber and Pabst [19] claim that fluoroscopy of the sinuses can readily be carried out

at the same time as fluoroscopy of the chest and may yield valuable information. They recommend it as a routine procedure, employing 60 to 70 kv. at 3 to 4 ma. The rays are directed through the occiput, with the face against the screen. With the head retracted the antrums, ethmoids, and frontals are projected above the petrous mass. The same position with the mouth wide open projects the sphenoids below the petrous. In a series of children thus examined, previously undetected pathology in the sinuses was uncovered in 10% of the cases.

Faaborg-Andersen,[20] seeking to evaluate routine roentgenography with the operative findings, reports his results in 13 cases. Filling with contrast media followed the routine x-rays within a few days, and surgery was performed from one to four days later. He found good agreement between sinography and operation in 12 out of the 13 cases. As for the routine x-rays, five cases showed good agreement with the operative findings and eight cases could not be evaluated.

The author shows that filling with a contrast medium will accurately delineate the thickness of the sinus mucosa. In the case of the routine x-rays, good agreement between the pictures and the operative findings can be obtained only in the regions where the mucous lining is struck tangentially by the x-rays.

Faaborg-Andersen [21] reports on the results in a series of ethmoid infections from the point of view of correlating the operative findings with the x-ray films. The series comprised 9 acute cases, 36 chronic cases, and 11 allergic cases. Although only a few of the cases revealed pus in the cells, the majority revealed definite evidence of pathologic changes wherever the previous x-rays showed blurring of the cell outlines. The other side of the picture, however, is less convincing insofar as negative x-ray findings are concerned, because in almost 50% of these cases some pathology was found in the cells. In other words, x-ray findings of cloudiness and hazy outlines are fairly accurate evidence of pathology being present; negative findings are less conclusive.

Ferreri and Capua [22] call attention to the floor of the frontal sinuses as visualized in the true lateral projection. The posterior wall or vitreous table of the frontal bone forms a U- or V-shaped curve which partially divides the cavity into a more or less horizontal portion and a vertical portion. Under normal conditions their boundaries show up clearly with well-defined uninterrupted ivory-like opacity.

A study of abnormalities in these curves is useful in the diagnosis of hypoplasia or aplasia, obliterating chronic frontal sinusitis, and frontobasilarinternal hyperostosis.

The authors show a number of illustrations (x-ray pictures) to demonstrate how differences in the outlines of these curves are helpful in the conditions mentioned.

Gaillard [23] cites several cases demonstrating the value of tomography with a contrast solution in the diagnosis of sinus infections causing dacrocystitis. He mentions the work of Worms and Tille and McGovern, who had previously called attention to the etiologic significance of sinusitis in disorders of the lacrimal apparatus, in which he is in agreement. He points out, however, that iodized oil is too heavy for injection into the lacrimal duct. Therefore, he has been using a 35% solution of iodopyracet (Diodone), which is much more fluid, and although less opaque, it is, nevertheless, sufficiently contrasting.

Pagliarani and d'Aiutola [24] report good results in a series of 15 cases of retrobulbar neuritis following Proetz displacement therapy. They used a commercial preparation, "Rinazine con sulfamide," a combination of a vasoconstrictor and a sulfonamide in an olive oil emulsion. The latter was thought to be of value as an emollient and because it maintained contact with the mucosa for a longer period than a watery solution. One to three instillations were used at intervals of 4 to 10 days. Four cases were cured, seven were markedly improved, and the rest, with one exception, showed demon-

strable improvement. They attribute failure to achieve cures in the majority of their cases to irreversible changes in the sinuses and to beginning atrophy of the nerve.

INTRACRANIAL COMPLICATIONS

Leroux and Merovici [25] comment on the difficulty in diagnosing sphenoiditis as the cause of meningitis, because frequently there is an absence of nasal discharge owing to obstruction of the natural ostium, the x-ray pictures are not always conclusive, and when orbito-ocular symptoms are present they are likely to be ascribed to an ethmoiditis. The case which they report developed a meningitis 13 days after the onset of headache and symptoms of a maxillary sinus infection. The spinal fluid findings were typical of meningitis except for the absence of bacteria.

When the antrum was opened and cleaned out they found a polyp in the extreme posteriointernal angle, which, when removed, led to an opening in the sphenoid. When this was extended they found the sphenoid full of a foul caseous material. The intersinus septum was eroded. The patient recovered after appropriate drainage and antibiotic therapy.

It was fortunate in this case that the infection broke through into the antrum; otherwise, it might have gone undetected until a more serious complication would have developed. It was pointed out that if there is coexistent otitis media the diagnosis is even more difficult. The authors refer to Eagleton's work on this subject, in which he showed how retrograde thrombophlebitis by way of communicating veins provided the route by which the infection passes from the sinus to the endocranium.

In another article Leroux [26] elaborates on the various clinical aspects of meningitis due to sphenoiditis, evidently with the case he reported (see above) in mind. He analyzes the symptoms and emphasizes the difficulty of diagnosis, because of the absence of local symptoms in most cases. The nuchal rigidity interferes with adequate positioning for good x-ray pictures, which adds to the difficulty. Much of the paper is concerned with references to the literature, citing Eagleton, Kramer and Som, Berger, and many others. He advises the transantral approach for cleaning out the antrum and ethmoids, which are frequently involved, and as a better means of exposing the sphenoids, both of which should be opened.

The case of subdural abscess of rhinogenic origin reported by Trowbridge and French [27] is interesting because of the influence of the antibiotics on the symptomatology and course of the process. The infection was lighted up by a swimming episode following a recent upper respiratory condition. Antibiotics seemed to suppress most of the symptoms except the blurring of the optic discs. However, after a lumbar puncture the patient developed a severe headache, became disoriented and confused. He was taken to surgery for a ventriculography, and when the dura was incised through occipital dural trephine holes, a large amount of pus was encountered in the left subdural space, which when cultured revealed a heavy growth of beta-hemolytic Streptococcus. The patient's condition deteriorated rapidly, and when it was determined that the drill holes were inadequate, a large frontoparietal bone flap was made and drains placed in all directions. Despite an aphasia and a spastic hemiplegia the patient recovered, with return to normal function. Later, the frontal sinus was completely cleaned out, at which time the posterior wall was found to have been eroded. A tantalum cranioplasty was done later to cover the defect.

Piquet [28] describes nonsuppurative encephalitis due to otic or rhinogenic infection, in which the chief pathologic findings are vascular dilatation, perivascular hemorrhages, and extensive changes in the brain substance, so severe as to lead to local necrosis but without suppuration. Clinically it is often difficult to distinguish it from a true brain abscess. It may come on acutely or may develop more slowly with fever, convulsive seizures, paresis, and disturbances

of personality. Signs of cortical irritation may be present as well as papillary stasis. The spinal fluid is clear or blood-tinged, with the cell count up to 300 or more, mostly lymphocytes and sterile. The course of the disease is usually favorable, subsiding within 8 to 10 days. Naturally, it is important that the otitic or rhinogenic focus be eradicated.

Pagnini [29] presents an interesting case of a frontal lobe abscess due to an odontogenic infection of the maxillary sinus. It involved a 26-year-old man who, after the extraction of a second upper molar, developed a sinus infection which necessitated a Caldwell-Luc operation. The mucosa was found to be fungoid and degenerated, and because the ethmoids seemed involved they were cleaned out through the antrum opening. During the next few days the patient began to manifest signs of psychic disorder, was apathetic, and seemed aphasic. Spinal puncture revealed turbid fluid under slightly increased pressure, with 82 polymorphonuclears. He soon became semicomatose, developed a lower facial paresis, and had some Jacksonian seizures. The frontal sinus was opened and seemed normal, as did the posterior bony wall. The dura was opened but no pus was found. However, a Cushing explorer encountered an abscess in the frontal lobe near the midline which seemed to be encapsulated. After appropriate drainage and large doses of antibiotics, the patient recovered, with no recurrences.

The author claims that he has found only one similar case in the literature, that is, a frontal lobe abscess following an odontogenic maxillary sinusitis. He believes the infection was transmitted via vascular channels, since the intervening frontal sinus was not affected.

Sambataro's [30] case was one in which a fracture of the supraciliary arch bordering the frontal sinus produced symptoms similar to a fracture of the posterior wall. A boy of 8 years of age was kicked by a horse, causing unconsciousness for 24 hours. The wound over the external part of the brow healed promptly. Four years later he exhibited signs of an acute meningitis, which subsided with sequelae. Subsequently he had two or three similar attacks. Finally, when he was examined in the clinic, x-rays showed a cloudy frontal sinus but no evidence of a fracture. He was finally operated upon, and when the bone was exposed a slight fissure was found, through which cerebrospinal fluid was draining, pulsating synchronous with the heart beat. The line of fracture was located and bone was removed, exposing an area of dura with granulations and a small fistula. The sinus was filled with purulent material. It was thoroughly exenterated; the dura was packed with gelatin material and proper drainage instituted. The recovery was uneventful.

Tello [31] reports a case of meningitis following exposure to cold and wet weather which, in his opinion, was due to a focus of infection in the antrum. It was complicated by a labyrinthitis, with total destruction of hearing and vestibular responses. The author emphasizes the influence of body chilling in the activating of latent foci and in the depression of body resistance and cites several authors who compare the process to anaphylactic shock and stress reaction.

BRONCHOPULMONARY COMPLICATIONS

Goldman and associates [32] formed a clinical research unit, including an allergist and a bacterologist, in an attempt to resolve the issue of sinus disease and asthma. One hundred nine patients were studied, and the investigation included x-rays, diagnostic lavage, and cultures of the washings. A number of tables are presented showing the bacteriologic findings, relationship to extrinsic and intrinsic cases, comparison of radiologic and bacteriologic findings, microbiology and micropathology of mucosa removed, and follow-up studies comparing results with radical antrum surgery and those without. It would appear from these studies that the sinus infection is superimposed on an allergic base and is not the

primary cause of the asthma, although it may contribute to its severity. This conclusion is based on the absence of infection in many instances, as judged by their criteria: no proof of sinus infection in many cases of intrinsic asthma, long-term bacteriologic studies suggesting the occurrence of transient and multiple infections, lack of correlation between x-ray and bacteriologic findings, and the failure to demonstrate significant micro-organisms either on culture or sections of mucosa showing typical allergic pathologic findings.

Comparing cases subjected to radical antrum surgery with those treated more conservatively indicates better results in the latter. The therapy should be conservative and only such surgical measures employed as are strictly indicated by nasosinal abnormalities or demonstrable persistent infection.

Grün and Hennemann [33] call attention to the not infrequent association of upper respiratory pathology as a focus for the persistence of lower respiratory affections. The former is often not discovered because of the paucity of symptoms and the fact that the areas are not closely investigated. They list a series of 49 cases of bronchitis, bronchopneumonia, bronchiectasis, lung abscess, etc., in which foci of infection were found in the sinuses and nasopharynx. They cite various theories as to how the association of infection in the two areas comes about. These embrace the idea of direct aspiration of infective material, the reflex action in the neurovegetative system affecting the reactibility of the tissues in the bronchopulmonary tract, and the theory of involvement of the entire respiratory mucosa. The main point of this article is the importance of thorough investigation of the sinuses for possible foci of infection in all cases of lower respiratory disease.

Negri [84] studied a series of 50 cases of bronchiectasis from the point of view of its relationship to infections in the upper air passages. Fifteen (30%) revealed pathology in the maxillary sinuses. In 20 of the cases (40%) agenesis of the frontal sinuses was observed.

On the other hand, a series of 70 cases of chronic sinusitis that were studied showed only one instance in which there was a concurrent bronchiectasis.

One case of Kartagener's syndrome is described.

The author is convinced that the concurrence of sinusitis, agenesis of the frontal sinus, and bronchiectasis is a phenomenon based on inherited or inherent deficiencies in the respiratory apparatus and that only rarely can one attribute disease in one area to infection transmitted from the other.

Another case of the Kartagener syndrome, in a 15-year-old girl, is reported by Teixeira, Vaz, and Costa.[85] Most of the bronchiectasis was in the right lower lobe, which was successfully resected. Examination of the excised tissue showed anatomopathological characteristics of an acquired bronchiectasis. There were no signs of congenital malformation of the lung. Nevertheless, the authors concede that a congenital predisposition must be present in these cases of visceral transposition.

OCULO-ORBITAL COMPLICATIONS

According to Weille and Vang,[86] sinusitis can rarely be proved the focus of infection in cases of uveitis, keratitis, or retrobulbar neuritis. In 244 cases where a focus hunt was instituted the results were positive in 108, out of which only 56 were in the sinuses. The results following surgery or conservative treatment were unsatisfactory in the majority of the cases insofar as relief of the ocular condition was concerned. In some cases temporary improvement was noted, only to be followed by recurrence of the eye symptoms after a lapse of variable periods of time. Typical cases are cited which illustrate the difficulty of drawing conclusions as to cause and effect.

The authors counsel great caution in the prognosis when sinus surgery is contemplated in these eye conditions. Definite pathology in the sinuses should be combated

for its own sake and minor conditions taken care of conservatively.

In 38 cases of retrobulbar neuritis, sinusitis could be proved in only 4, and in only 1 of these was the connection definite.

Castroviejo and Casanovas [37] present briefly the histories of 25 cases of keratitis, keratoconus, and other anterior chamber conditions in which intercurrent respiratory infections played a vital role. Keratoplasties and corneal transplants showing favorable postoperative healing were followed by uveitis and hyalinization of the transplants due to subsequent infections of tonsils, sinuses, and other locales. Tuberculosis also was found to be a factor in unfavorable results if uncontrolled or suddenly activated. The authors have found that the cornea and uveal tract are extremely sensitive to infection, especially in adjacent structures, and it would appear, from their experience, most imperative that such foci be eliminated, particularly if surgery is contemplated.

Fazakas [38] analyzes the ocular symptoms arising out of 10 mucoceles, 8 of which originated in the anterior ethmoid cells, 1 from the frontal sinus and adjacent ethmoids, and 1 from the frontal alone. In one case the mucocele was suboptical, which is very unusual, and in another case the picture closely resembled a chronic dacryocystitis. In eight cases a widening of the blind spot was observed, the direction varying according to the site of the mucocele. Exophthalmos and double vision, frequently encountered, are also more dependent on the location of the mass rather than its size.

SINUSITIS IN CHILDREN

Dickey [39] reports five cases of Kartagener's syndrome in children, aged 6 weeks and 4, 9, 10, and 14 years. Four of the five had complete situs inversus; one, dextracardia only.

Lobectomy was performed in three patients, with beneficial results. All of the patients showed definite evidences of sinus disease, confirmed by x-rays in four.

The author feels that a congenital factor plays a prominent role in the pathogenesis. Atelectasis in most of the cases appeared to precede the bronchiectasis.

Several interesting bronchograms are shown as well as a section of excised lobe demonstrating the marked dilatation of the bronchioles.

Mawson and Gray,[40] noting a marked difference in the findings of Birrell [41] and a number of other investigators as to the incidence of maxillary sinusitis in children, examined 50 children admitted to the hospital for routine tonsillectomy. Birrell had reported pus in 9.4% and mucopus in 4.4% of his cases, whereas other authors found the percentage much higher, varying from 22% to 76%. Mawson and Gray punctured the antrums of children under endotracheal anesthesia, using double cannulas. Secretions were centrifuged and the concentrate cultured in blood agar and in sloppy agar tubes. A sinus was classified as infected if the preoperative films and the cultures were in agreement, or if, when a growth could not be obtained, the appearance of the film was unequivocal.

The authors found "acceptable evidence of chronic infection in 11 previously unsuspected antra out of a total of 50 investigated, an incidence of 22%, and of infection in 35 suspected antra out of 77 investigated, an incidence of 45.4%."

The authors discuss Birrell's explanation of the low incidence in his series, pointing out their difference of opinion as to acute sinusitis in children and the basis for diagnosis. Other controversial points are analyzed. Also, some suggestions are offered in the matter of therapy.

Sprockhoff [42] became interested in sinobronchitis when his own 3-year-old daughter had an intractable chronic bronchitis. Also, reports in the American and Swiss literature began to attract his attention. As a result, he was surprised to find 27 cases of chronic bronchitis in which positive roentgenologic evidence of maxillary sinusitis was found. He therefore strongly recommends routine

x-rays of the sinuses in all these cases. He summarizes the subject as follows:

Definition: Chronic bronchitis with concurrent chronic maxillary sinusitis.

Anamnesis: Nasal obstruction, coughing spells at night, morning hacking, and periods of fever.

Family history: Often similar conditions among blood relations.

Helpful signs: Unilateral nasal discharge of mucoid discolored secretion on the posterior wall of the pharynx, enlarged adenoids, granular pharyngitis.

Therapy: Remove the adenoids. During acute exacerbations vasoconstrictors and spot suction; short wave; antibiotics. In the congenital or long-standing cases, short wave, x-rays, change of climate; limited irrigation.

Prognosis: Good in most cases, depending on how early treatment is instituted and how energetically carried out. Doubtful in the congenital cases. Danger always of bronchiectasis, emphysema, and heart complications.

Bjuggren and associates [43] found a definite correlation between the x-ray findings and the results of antrum lavage in a series of children. The more opaque the film the more likely that the lavage would be positive. Also, there was relationship between the x-ray findings and the types of bacterial flora. Pneumococci are quite common in the nasal passages of children but not in the sinuses unless a sinusitis is present. In that case the cultures direct from the sinus will show pneumococci, and this will be commoner when the x-rays show opacity. Influenza bacilli are next in frequency but play a subordinate role, except in prolonged cases of sinusitis. Apparently this germ has the capacity to survive during periods when the sinusitis quiets down. Another finding of some significance is the sedimentation rate, which the authors found to be accelerated in cases where the x-rays were positive.

Commenting on the role of the adenoids, the authors do not consider them as definite etiologic factors in sinusitis. They concede that it is possible that adenoids may become infected from a sinusitis and, conversely, that enlarged infected adenoids may contribute to the persistence of a sinusitis.

As for therapy, they believe that penicillin should be used and is effective in the pneumococcic infections. If the predominant organism is the B. influenza or the Staphylococcus, chlortetracycline (Aureomycin) or oxytetracycline (Terramycin) or chloramphenicol (Chloromycetin) should be more efficacious. In addition, local aspiration and occasional antrum lavage may be beneficial.

Bryant [44] reports a series of 43 children with chronic maxillary sinusitis in which good results were obtained through enlarging the normal ostium in the middle meatus. This is followed by the administration of penicillin and streptomycin, local packs, and a modified displacement. In a group of 18 children whose tonsils and adenoids were still present, the parents reported relief or improvement in 14. Likewise, in the 25 cases whose tonsils and adenoids had previously been removed, the treatment resulted in relief in 12 and improvement in 8.

MISCELLANEOUS COMPLICATIONS

The first of the three cases of osteomyelitis reported by Johnson [45] was in a boy of 14 with a history of trauma a few days previous to examination, who died despite prompt and extensive surgery, with full doses of antibiotics. Autopsy revealed a malignant glioma involving both frontal lobes of the brain, with a recent infarct. This finding was entirely unpredicted, since thorough and repeated neurologic examinations during his illness failed to disclose any sign which might have led to a suspicion of tumor.

The second case recovered after radical surgery and antibiotic therapy. The offending organism was a hemolytic coagulase-positive Staphylococcus sensitive to oxytetracycline and streptomycin.

The third case was in a boy of 13. In this case a large extradural abscess was uncovered which was not walled off. A

second operation was performed later, after the intracranial symptoms recurred. This time a cerebral abscess was discovered in addition to a large extradural abscess. The organism was an anerobic nonhemolytic Streptococcus sensitive to penicillin and streptomycin. The boy recovered, although a paresis of the arm and external recti persisted for several weeks before clearing up.

The author emphasizes Mosher's observation that x-ray findings of osteomyelitis lag far behind the clinical symptoms. Also, he points out that when an extradural abscess is found which is not entirely walled off one must remove the surrounding bone radically and inspect the dura for possible subdural extension. The situation is different if the abscess is walled off, because the margins usually represent the dividing line between healthy and diseased bone.

Svartz [46] does not find that infections of the upper air passages have any etiologic significance in the development of rheumatoid arthritis. Analysis of the history in 947 patients revealed only 1.7% showing any evidence of sinusitis.

Rheumatoid arthritis displays all the evidence of being an infectious process, as revealed by the cytologic picture of the joint exudate and the reaction of the hemagglutination. Yet, attempts to link it with infections of the tonsils, teeth, or sinuses have failed, as evidenced by the poor results of surgery.

Labyrinthitis without otitis media or mastoiditis but due solely to a sinus infection is extremely rare. The case reported by McKim [47] was in an 11-year-old girl who, in the course of an upper respiratory infection, developed spontaneous nystagmus with vertigo and vomiting. Meningeal symptoms were absent, and all cranial nerves were functionally normal. The patient was too ill for caloric tests. X-rays showed a pansinusitis, yielding Hemophilus influenzae on culture. Therapy consisted of antrum irrigations, local decongestants, steam inhalations, and antibiotics. Recovery was uneventful.

MALIGNANT TUMORS

Cranmer [48] presents an analysis of 91 cases of malignant tumor of the sinuses observed at the University Hospital, Ann Arbor, Mich., from 1932 to 1948. Swelling and pain in the cheek were the earliest symptoms complained of. This would appear to be contrary to the experience of other authors who have said that these are rather late manifestations. Other symptoms noted were unilateral nasal obstruction, epistaxis, and oral symptoms. The author finds it difficult to classify these tumors by location because of the involvement of multiple sinuses in most cases. All but 17 of the group involved two or more structures.

Therapy consisted of excision, electrocoagulation, cautery, and irradiation. All in all, the survival rate was 22% for three years and 14% for five years. Naturally, some of the cases were more favorable than others, due to earlier recognition and easier accessibility.

Recurrences being frequent, it is well to follow the cases with repeated therapy, since they do not metastasize early.

Logue and Barrett [49] discuss the diagnosis and therapy of malignant tumors of the sinuses, citing a number of well-known authorities on the subject. The conclusions are the following:

1. Early diagnosis is difficult because of the paucity of symptoms.

2. Diagnosis may be suspected from the history and x-ray findings and confirmed by biopsy.

3. Surgery, with or without irradiation, will yield a fair percentage of cures in selected cases.

4. Growths below the attachment of the middle turbinate offer a much better prognosis than those extending above.

Surgery is contraindicated if there is evidence of extension to the base of the skull or to the walls of the nasopharynx; also, if visceral or skeletal metastases are present.

A review of 19 cases of malignant disease of the nose and sinuses by Vald. Poulsen [50] showed better results in the sarcoma cases

than in the carcinomas. This is attributed to their greater radiosensitivity. Seven of the 19 cases recovered after the therapy outlined by Ohngren, in which surgical diathermy is combined with irradiation. Most of the fatailties were in cases where the tumor involved the ethmoid with extension into the cribriform area and brain.

Winborn,[51] analyzing several cases of malignant disease of the nose and sinuses, comments on the futility of a timid approach. Since early diagnosis is so frequently missed until the growth has involved vital structures, the only hope of cure rests in sufficiently radical surgery combined with intracavity and external radiation. Once the mass has invaded the base of the skull or spread to the regional lymphatics, there is little that can be expected beyond palliative measures.

Heatly[52] presents two cases of plasma-cell tumor involving the maxillary sinus. He discusses the nature of the growth, particularly its similarity to multiple myeloma; although classed as a malignant growth, it is slower in progression than myeloma, with metastases appearing late and frequently not diagnosed. Histologically it presents a solid growth of plasma cells in clusters, with very thin connective-tissue septa and a marked development of capillaries.

These growths are fairly sensitive to radiation, which in most cases is preferable to radical surgery.

In the first case reported by the author, the patient survived four years after the onset of the maxillary growth. Autopsy revealed metastases in the spine.

The second case showed no evidence of recurrence after three years, but the patient, a chronic alcoholic, died of poisoning, having accidentally taken carbon tetrachloride cleaning solution (Carbona).

Guarnaccia[53] reports a case of fibrocystic osteoid tumor of the von Recklinghausen variety in the ethmo-orbital region. Preceding the appearance of this mass the patient had shown evidence of similar lesions in other parts of the body, including a fracture of the femur. The orbital mass increased in size, causing an exophthalmos, displacement downward and outward, and impaired vision. X-rays revealed areas of bone absorption throughout the cranium and in numerous skeletal bones. Blood calcium was 13% and phosphorus 7.5%. The mass, which involved the frontal and all of the ethmoid, was removed through a supraorbital incision. Histologic examination revealed areas of bone absorption, increase in fibrous mass with numerous cystic cavities. The patient recovered and vision returned to normal.

Berdal and Mylius[54] summarize their experience in treatment of 12 cases of cylindroma during 1953. It is their belief that these tumors should be classified among the group of salivary gland tumors occupying a position between benign adenomas and malignant adenocarcinomas. They are found in areas where salivary tissue is present and present a firm elastic slowly-growing mass, usually covered by mucous membrane or skin, with ulceration in advanced stages or from surgical trauma. They can infiltrate muscles, periosteum, and bone, and they metastasize slowly. There is a marked tendency toward recurrence after surgery or irradiation.

There were two cases in the series involving the ethmoid, maxilla, and orbit. In both cases there were recurrences.

Successful extirpation can be accomplished only by thorough primary excision, in which the limits are determined by frozen sections from the periphery at the time of operation. Great stress is laid on the close cooperation between the surgeon and the pathologist.

Irradiation is recommended as supplementary therapy in operable cases and for palliation in operable tumors. The article is amply illustrated.

Adenocarcinoma of the sinuses is quite rare, comprising only about 7% to 8% of malignant growths in this area. The case reported by Hibbs and Teloh[55] was in a 63-year-old man, who stated that two years

previously a biopsy specimen taken from his middle turbinate was diagnosed as cancer, after which he was treated with an application of radium and implantation of radon seeds. This failed to halt the progress of the tumor, which within a few months extended into the opposite side of the nose. When he was first seen by the authors the examination revealed absence of extraocular movements and exophthalmos, decrease of pupillary reflexes, papilledema, and palpable nodes.

The eye was enucleated, a radical maxillary sinusotomy was done, and intensive x-ray therapy instituted. The tumor had already invaded the base of the brain. The treatment was only palliative, the patient surviving less than a year.

Autopsy showed the growth replacing the entire ethmoid, extending through the cribriform plate into the cranial cavity up to and including the sella turcica and body of the sphenoid.

Histologic studies showed a well-defined mucinous adenocarcinoma. This type of growth is closely related to similar tumors of the bowel and breast.

A remarkable case of fibrosarcoma of the ethmoid is presented by Stratton.[56] The patient, a 56-year-old man, was first seen with a swelling on one side of the nose and a fleshy mass filling the nares, which, on biopsy, proved to be a typical spindle-cell sarcoma. A Caldwell-Luc and external ethmosphenoid exenteration was done, followed by 2800 r of radiation, which caused a severe reaction. Almost a year later he was seen again with symptoms suggesting intracranial pressure. An encapsulated frontal lobe abscess was drained via a burr hole, and the patient recovered. While convalescing he suffered a recurrence of the pansinusitis, with involvement of the opposite side. When he was reoperated on, an extradural abscess was found with sarcomatous tissue over the roof of the frontal sinus. Again he was irradiated, but treatment was suspended at 910 r because of severe skin reaction. A few months later the brain symptoms recurred, necessitating a second exploration, at which time 60 cc. of thick pus was evacuated. Rapid improvement followed under chemotherapy, and since November, 1949, he has been comparatively comfortable except for occasional headaches and epileptiform attacks, presumably due to the scarring at the site of the brain abscess. A photograph shows a permanent opening in the supraorbital region, through which the pulsating dura is readily visible.

Reynon and D'Haussy[57] give a detailed description of a case of sarcoma of the ethmoid which developed rapidly, without pain, in a man of 45. He came in with marked protrusion of the right eye, no impairment of vision, and only slight limitation of motion. A dense mass could be felt at the internal angle which was tender to pressure. The mass extended down into the nasal cavity as far as the inferior turbinate. X-ray pictures showed absorption of the superior and internal orbital walls and the lesser wing of the sphenoid. Since it was inoperable, it was treated with x-rays, but without effect. The histologic diagnosis on biopsy was chondrosarcoma.

Heatly,[58] while commenting on the relative infrequency of tumors in the maxillary sinus, brings out the point that the embryologic development of the upper jaw with ectodermic and mesodermic elements in complex formation predisposes to the occurrence of cell rests, which later develop into tumors. He goes over the list of such tumors as adamantinoma, plasmocytoma, cylindroma, chondroma, and malignant types, giving briefly the characteristics of each.

Symptoms are frequently late in appearing, so that at times the mass may reach considerable size before being brought to the attention of a physician. This can be of serious import in the case of a malignant tumor. X-ray studies and biopsy are of immense value in the diagnosis.

The outlook in many cases has recently improved because of antibiotics, improved techniques in anesthesia, and a better understanding of irradiation therapy, which is a

valuable adjunct to surgery and other procedures. Ultimate success depends a great deal on a thorough understanding of the nature of the tumor, its tendency to local recurrence, and the degree of malignancy, if such be evident at the outset or probable in the course of its growth.

NONMALIGNANT TUMORS

Schuster and Flynn [59] report a case of eosinophilic granuloma of the frontal bone in a child of 3 years. The swelling appeared shortly after trauma had been inflicted with a wooden stick. Biopsy revealed eosinophilic granuloma. X-rays showed an irregular area of bone destruction 3.5 by 3.5 cm. in size, in the anterior aspect of the frontal bone, extending into the orbit. Laboratory work was essentially negative, as was the neurologic examination. The mass was removed through an external incision. It consisted of yellowish-brown friable tissue which had eroded the supraorbital rim and had exposed an area of dura about 2 cm. in diameter.

Pictures taken several months after healing showed considerable regeneration of bone. Histologically the specimen showed clumps of eosinophiles in a reticular network; also, some giant cells, plasma cells, and lymphocytes. The authors claim that surgical excision in these cases is to be preferred to irradiation therapy.

Kessel [60] presents a very interesting résumé of nine cases of osteoma, six of which were orbitoethmoidal and three frontal. Among the former there were three complicated by intracranial pneumatocele. In one case the patient was safely carried through an attack of meningitis before the mass was attacked. In another case hemiparesis was present along with other symptoms of cerebral pressure. This was the only case in the series that ended fatally. The third case also presented symptoms of localized brain pressure. In all three of these cases the dura was eroded.

The author discusses the formation of a pneumatocele, whereby air from the sinuses finds its way into the epidural or subdural space, eventually reaching the ventricular system, as shown in several of the illustrations. This comes about from either a fracture of the skull, operative trauma, or erosion. Diagnosis is readily made by x-rays and by the presence of rhinorrhea.

Discussing the therapy, the author finds that the direct approach through the sinus is applicable only to cases where the tumor is entirely within the sinus confines. In other cases, where the orbit is involved or the growth encroaches on the eribriform area, and particularly in cases of rhinorrhea and pneumatocele, the only feasible approach is transfrontal. This alone will furnish adequate exposure so that the damaged dura can be properly repaired. He advises a coronal incision exposing the entire frontal area. In practically all of these cases it is necessary to obliterate the sinus. The article is very instructive.

Koch, Koch, and Welin [61] discuss the diagnosis of mucocele developing in the frontal sinus subsequent to surgery. Contrast medium injected through the operative defect in the bone shows the contour of the mucocele in the x-ray pictures of two cases. These cases were originally operated on by the Bárány technique, and secondary operations revealed obstruction in the nasofrontal duct in one instance and a thin partition dividing the sinus in the other.

Shea [62] discusses the theories relating to the pathogenesis of nasal polypi, embracing allergy, infection, and endocrine disturbances. He points out the importance of differentiating them from angioma, mucocele, and malignant growths. Also, he advises caution in the removal of polypi above the attachment of the middle turbinate, since avulsion of such growths emanating in the superior meatus may result in an atrium to the cranial cavity.

The various forms of therapy in addition to surgical removal are mentioned, such as ionization, Robinson's pressure balloon procedure, radium therapy, and cortisone sprays, all of which have been reported with varying results. He suggests a field for research in the possible development of a therapy which would produce a shift in the

body pH to alter the tissue tendency toward the re-forming of recurring polypi.

Fineberg [63] removed a small osteoma situated in the midline on the anterior wall of the frontal bone, just above the glabella, by an intranasal approach. The soft tissues over the nasal dorsum were elevated through the conventional intercartilaginous incision, and the small bony excrescence was chipped off with a guarded chisel. The author claims this procedure has the advantage over an external approach through the avoidance of a scar. It is patently limited to a very small group of tumors.

Cervantes [64] reports two cases of severe recurring headache due to maxillary sinus cysts cured by surgical removal. In one instance the headaches had been present for five years and in the other for eight years. In both cases the x-rays showed diffuse cloudiness of the sinus. Several exploratory punctures were done, yielding a clear fluid containing cholesterol crystals. Contrast media injected into the sinuses revealed the outline of the cysts. In one case there were five cysts in the antrum. Histologic examination of the tissue revealed chronic hyperplastic inflammation of the mucosa.

Frech [65] reports a case of true cholesteatoma of the maxillary sinus in a child of 3 years. There were no symptoms until the appearance of a swelling in the cheek, which was at first diagnosed as a cyst after exploratory puncture yielded a yellowish fluid. X-rays revealed a diffuse shadow of the entire sinus, with displacement of the cuspid tooth. The mass was removed via a Caldwell-Luc exposure and consisted of a multilayered epithelial squamous-cell lining, with papillary projections into the basal connective tissue. The contents of the cavity consisted of masses of desquamated epithelium.

The author cites this as a rare example of true cholesteatoma, which is seen oftener in the frontal than in the maxillary sinuses. He cites many reports of pseudocholesteatoma from the literature and points out the differentiating features. The diagnosis rests on the presence of the masses of desquamated epithelium and the absence of any evidence of previous inflammatory or traumatic residue, such as cicatricial connective tissue.

Tamari and Baer [66] advise an external approach through the eyebrow for the removal of mucoceles of the frontal sinus. They describe the various operations for frontal sinusitis and usually select the Lynch or Killian procedure, emphasizing the importance of visualizing the entire cavity, adequate removal of the floor, including anterior ethmoid cells if necessary, to provide a wide passage into the nasal cavity. A rubber tube is left in place for weeks if necessary. They do not favor the intranasal approach unless the mass presents itself within the nose, because it fails to afford a view to the extent of the mass and occasionally one may miss seeing a dehiscence of the bone toward the orbit or the dura.

Malatesta [67] considers his case of mucocele unusual because of the close connection between the trauma sustained and the appearance of the mass. It was a matter of only a few months following the accident when the swelling appeared at the superointernal angle of the orbit, with displacement of the bulb. The x-rays showed absorption of the internal plate of the orbit, and at operation it was found that the roof was also eroded, exposing the dura. Histologic examination of tissue removed failed to reveal any epithelial lining in the sac. The author believes it was obliterated by the pressure of the rapidly growing mass.

Maktav's [68] case of mucocele was in a man aged 35, who gave a history of trauma involving the upper lid some 10 years previously. There were no symptoms in the interim until the appearance of a nut-sized welt in the region of the scar. X-rays revealed a tumor-like mass in the frontal sinus about the size of an egg, in addition to the smaller external mass. The usual external operation was employed.

Taillens [69] seeks to analyze the subject of nasal polyposis on the basis of a study of 180 cases, in which the pathology,

genesis, and hematologic factors are all investigated. He postulates some 14 conclusions, which add up to two major premises, namely, nasal polyposis is not an entity in itself but a component of a sinus polyposis based on a combination of allergy and superimposed infection. The sinus condition usually precedes the nasal condition, and the therapy depends on whether the eosinophile count is above or below 10%. If above that figure, the case is deemed a purely allergic one and antiallergic therapy is indicated. However, if it is below 10%, a bacterial infection must be considered and such cases then submitted for a Caldwell-Luc and transantral ethmoidectomy.

This is a detailed article, which contains a number of instructive diagrams and x-ray pictures.

SURGERY

Harpman [70] devotes most of his paper to a description of the procedure he favors for the eradication of a pansinusitis with polypi. It is a modification of the Lynch-Sewell-Luongo approach, whereby all the sinuses, including the antrum, are dealt with through the one external incision. The latter is far enough forward to insure its lying over intact bone. It curves upward and outward through the brow but rarely beyond the supraorbital notch. The periosteum is elevated from the median orbital wall to the anterior ethmoid vessels, from the floor of the frontal sinus, not usually lateral to the supraorbital notch, and downward to the floor of the orbit. The lacrimal sac is elevated from its bed, and the pulley of the inferior oblique is carefully detached. The lacrimal bone is perforated and the breach enlarged so that most of it is removed along with the nasofrontal process of the maxilla, the descending process of the frontal bone, the floor of the frontal sinus as far as the supraorbital notch, and the anterior part of the lamina papyracea, usually as far as the anterior ethmoid vessels. If it is necessary to go deeper, the vessels are divided between Cushing clips. The frontal sinus mucosa is removed, the ethmoid labyrinth cleaned out, most of the middle turbinate excised, and the sphenoid sinus opened and cleaned out. The author does not find it necessary to ligate the sphenopalatine artery, nor does he extend the bony breach beyond the floor of the sinus.

The maxillary sinus is entered by removing bone from around the upper part of the tear duct, the superomedial part of the anterior wall, and the anteromedial portion of its roof. He has found it possible through this opening to remove the diseased antrum mucosa with the Watson-Williams polyp forceps. The nasoantral wall is removed above the inferior turbinate so that an additional infraturbinal opening is not necessary.

The author states that in most cases the frontal sinus and antrum fill up in the main with fibrous tissue, which practically obliterates them. This process is facilitated by filling the cavity with paste of plasma powder and penicillin.

The author has never been satisfied with any of the operations designed to maintain the patency of the sinus and has given them up. He is convinced that following a radical exenteration the sinus should be encouraged to obliterate itself through the formation of fibrous tissue.

Padrón [71] contributes another in his long series of articles on the sinuses, which have been appearing during the past year or more in the same journal. This one deals with the surgical treatment of sphenoiditis, alone or in association with disease of the other sinuses. When the ethmoids are affected, the approach to the sphenoid is easier than when the latter is the only one to be opened. The intranasal route is adequate, although the complications of hemorrhage, headaches, and postoperative crusting may be troublesome.

If both sphenoids are involved and the septum is deviated, the author suggests the transseptal route as described by Hirsch in his approach to the hypophysis and later by Spies and Segura. The technique is explained in detail. He cautions against curetting the sphenoid mucosa unless it is

polypoid or fungoid. This may be difficult or even dangerous if there are deep recesses beyond the range of vision, particularly in the region of the optic canal. One must always bear in mind the possibility of a dehiscence in the bony wall.

The author calls attention to the possibility of sensitivity to the local anesthetic, which, according to some authors, may involve 2% of all cases. He therefore suggests preliminary patch, scratch, or intradermal tests. When the maxillary sinus is also involved, he recommends a transantral approach, either the Denker or Lantenschlager, as offering the most adequate for exenterating all of the sinuses. Here, also, the technical details are described.

Pietrantoni and Manzini [72] review the results of surgery in 63 cases of polypoid hyperplastic rhinosinusitis over a period of four years. The procedures were variable: all the way from simple polypectomy to radical exenteration, combined in some cases with irradiation. It was found that the more radical the intervention the less frequent were the recurrences, especially if the procedure was a transantral ethmoidectomy with a clearing of the maxillary sinus followed by local postoperative x-ray therapy.

In appraising the results, the authors divided their cases into three groups:

1. The unmistakable allergy cases. Surgery contraindicated.

2. Probable allergy in connection with bacterial inflammation. Radical surgery offers the best prospects for a cure.

3. Polypoid hyperplasia of sinus mucosa without evidence of allergy. Should be operated upon by the Pietrantoni-Lima technique.

The authors found that local irradiation was very useful in retarding recurrences, and it was employed in all the surgical cases irrespective of the extent of the surgery.

Dingley [73] compares the relative merits of intranasal antrostomy and the Caldwell-Luc by the following criteria:

1. Accessibility of surgical approach
2. Surgical technique and instruments employed
3. Indications for each operation
4. Disadvantages of each method

The author finds that the Caldwell-Luc approach is much more accessible than the intranasal operation. The latter is "around the corner," involves damage to the inferior turbinate, and affords only limited visibility of the interior of the sinus. Another disadvantage lies in the inadequacy of instruments thus far available, making it difficult to lower the nasoantral wall to the proper level. Also, construction of an adequate mucosal flap to cover the denuded bone is extremely difficult. These objections do not prevail in the case of the Caldwell-Luc, where the instruments are adequate and the approach is simple.

The author restricts his indications for antrostomy to cases where limited drainage is required to clear up subacute infections which resist more conservative procedures. It is the method of choice for adolescents, especially if the nasal passages are sufficiently wide. The Caldwell-Luc is recommended in cases where the nasal passages are narrow, cases of dental origin, for the removal of foreign bodies, and in instances where the bony walls are thick.

As for disadvantages, he mentions trauma to intranasal structures incident to the antrostomy operation and the likelihood of the opening closing up. In the case of the Caldwell-Luc one has to consider postoperative edema and anesthesia of the lip and the teeth, the latter frequently of long duration. However, he has never observed any damage to the vitality of the teeth in any of his cases. Neither has he encountered any greater constitutional disturbance or postoperative pain than in the other procedure.

Boies [74] discusses the relative merits of intranasal antrostomy *vs.* Caldwell-Luc and concludes that the former should be the method of choice except in selected cases of unusually extensive pathology or in edentulous patients. From his listing of a series of only 30 operative cases over a period of 10 years, it is evident that the tendency toward conservatism has become more pronounced in recent years, due, no doubt, to appreciation of allergic factors

in sinus manifestations as well as the use of antibiotics. Eleven of the cases had antrostomies and the remainder the Caldwell-Luc. All the cases were followed for some time postoperatively, and the results were eminently satisfactory.

Mawson,[75] comparing intranasal antrostomy with the Caldwell-Luc, lists the advantages of each as follows: Antrostomy: performed more rapidly, under local anesthesia; little bleeding, shock, or discomfort; without the sequelae of sensory disturbances. Caldwell-Luc: free inspection of the interior; readily accessible for removal of diseased tissue, foreign bodies; more certain placement of adequate counteropening into the nose. When the operation is performed under proper indications, the results in both instances are favorable, as reflected in a study of about 100 patients, who were examined several years after surgery.

The summary was as follows:

	Antrostomy	Caldwell-Luc
Cases followed up	53	51
Patent antrostomies	64%	80%
Closed antrostomies	36%	10%
Infected noses	17%	25%
Clean noses with patent antrostomies	62%	71%
Clean noses, symptom-free	83%	75%

In general it was found that the intranasal operation was more suitable for the cases of more recent origin, whereas long-standing cases with purulent discharge and x-ray findings of marked changes in the mucosa required a Caldwell-Luc.

Shattan,[76] after extracting a second left upper molar, found a spontaneous communication with the antrum about 2 cm. in diameter and a fracture of the buccal plate of the alveolus exposing the floor of the antrum. The opening was closed by a modified Berger[77] procedure. An impacted third molar was removed to gain additional tissue for the buccal flap necessary for the plastic closure. The author credits antibiotic therapy as a contributing factor in the healing.

McNally and Stuart[78] analyze a series of 77 cases of frontal sinus cases subjected to external operations. This group represented only a small portion of all the cases of frontal sinusitis encountered in a 30-year period (425), being those that could be followed up for proper evaluation. The material presented is thoroughly analyzed as to acute, chronic, or chronic with allergy; type of operation employed; influence of chemotherapy or antibiotic therapy, and results. There were 22 acute fulminating cases, half of which occurred after swimming. Symptoms of intracranial involvement were present in half the cases. Despite osteomyelitis, all but two recovered. In most of these cases the sinus was surgically ablated.

The greatest trouble encountered was in the maintenance of a patent nasofrontal duct, despite a variety of procedures employed. The results in 10 cases where tantalum foil or tantalum tubes were used were not entirely satisfactory. Out of a total of 25 cases where the status of the duct could be determined, 16 were found to have closed at periods of from a few months to 40 years. It is apparent that this phase of frontal sinus surgery is still a matter for further investigation and research.

Goodale[79] has been using tantalum in frontal sinus surgery for almost 10 years and presents his evaluation of the results in 20 cases which could be followed up. In two cases the tantalum foil was improperly introduced, necessitating removal. In a third case the tantalum was removed at another clinic under the mistaken diagnosis of a foreign body. In another instance the foil was displaced through injudicious probing and had to be removed.

There were three cases in which the results were disappointing, not because the implant was causing trouble but because its use was not strictly indicated according to the subsequent findings.

In the remainder of the cases the results were very satisfactory, accomplishing the purpose of maintaining an adequate passage into the sinus without in any way giving rise to any subjective or objective symptoms.

Smith[80] found that out of 20 cases of frontal sinus disease operated on since 1945 there were 14 in which characteristic nasal

symptoms were absent. These cases represent a wide variety of conditions. In 10 of them the principal finding was an obstruction of the sinus outlet, while in the other 4 cases the pathology originated outside of the sinus proper. In the former, the pathologic reaction in the bony walls was variable: atrophy from pressure in some or hyperplasia and thickening due to inflammatory reaction. Six of these cases showed characteristic x-ray findings of mucocele.

The author stresses the importance of careful diagnosis and early therapy in cases where nasal symptoms are meager. Antibiotic therapy will alter the course of a frontal process but in many instances will have to be supplemented by adequate surgery once the diagnosis is made.

Tato and associates,[81] after reviewing the history of surgery of the frontal sinus, discuss the relative merits of conservation with improved drainage as against obliteration. The authors favor a procedure which includes an osteoplastic flap, eradication of the sinus contents, and filling the dead space with transplanted abdominal fat. Several interesting drawings and x-ray pictures illuminate the text.

Goodyear [82] covers briefly the treatment of several sinus conditions with orbital symptoms. For the relief of severe pain of acute frontal sinusitis following swimming, he suggests cold compresses and a nasal spray of cocaine and phenylephrine in boric acid solution every few minutes. If x-rays show a fluid level he recommends infracting the middle turbinate and entering the sinus with a small cannula to drain the fluid. At times it may be necessary to perforate the floor of the sinus externally.

In chronic frontal sinusitis the author prefers an intranasal operation, especially if the x-rays show sufficient width and depth at the isthmus. Recurring exacerbations following an external operation are best handled by reopening the sinus externally and placing an Ingals gold tube in the region of the duct. This tube may be retained for years.

Mucoceles or pyoceles should be opened intranasally and the lining of the cavity left undisturbed, being epithelium, which is desirable.

Corneal ulcers frequently are due to an antrum or tooth infection, which can be definitely diagnosed by x-rays with contrast media. Also, he has found daily injections with small doses of insulin (3 units) effective. Optic neuritis may respond promptly to opening the posterior ethmoids and sphenoid. Also the author reports equally good results in some cases following the instillation of chloriodized oil (Iodochlorol) into the sphenoid sinus.

NONSURGICAL THERAPY

Doyen,[83] after a thorough analysis of a series of cases of chronic sinusitis, agrees with the authors whom he cites that penicillin therapy locally applied is ineffective in most cases of hypertrophic maxillary sinusitis. After a thorough trial many of these were operated upon and revealed irreversible changes in the mucosa. Cases that are less advanced will be greatly improved under penicillin instillations and frequently remain symptom-free for a period of time. Yet, in the real chronic bacterial infections the relief is only temporary, since the bacteria in the thickened membrane are readily reactivated. It may be difficult to determine whether a case temporarily improved is really cured. This does occasionally happen and can be proved by the change in the x-ray pictures, return of translucency, and absence of discharge.

Van Alyea [84] advises conservatism in the management of acute maxillary sinusitis. Drainage is facilitated through measures which will unblock the middle meatus. These consist of shrinking agents applied by means of a pack containing a mild local anesthetic and a vasoconstrictor. Antibiotics are given only in severe cases. Local heat and anodynes will tide the patient over the most acute stage. As this subsides, irrigations may be undertaken. Instillation of antibiotics has been found of little value. If

infection persists, one should infract the middle turbinate and attention should be directed to the ethmoids or to a possible dental focus.

In chronic cases every effort should be made to improve the ventilation and drainage by freeing the middle meatus of polypi, infracting the middle turbinate, possibly resecting the septum if it is contributing to the blockade. Instillation of contrast solutions will demonstrate the state of the antrum mucosa. Where the natural ostium is inadequate for irrigation and drainage, it may be necessary to provide an additional opening via the inferior meatus.

Kinghorn, Wilson, and Divorski [85] have had good results from the use of a specially prepared autovaccine and filtrate in both chronic sinusitis and chronic nasal catarrh. The latter refers to cases of chronic nasal and postnasal discharge in which x-rays, transillumination, and other diagnostic means fail to disclose definite involvement of the sinuses. Staphylococcus aureus was found on culture in all of the cases; Staphylococcus albus and hemolytic Streptococcus were encountered less often.

The method of preparing the vaccine and supernatant fluids is described in detail, and dilutions of from 2,000,000,000 to 40,000,000,000 organisms per cubic centimeter are prepared.

The patient is tested for sensitivity by intradermal injections of both the vaccine and filtrate in various dilutions. Injections are given of both preparations intradermally, beginning with 0.05 cc. once a week, the same dose being repeated for three successive injections before being increased. In the sinus cases, the filtrate is instilled into the sinus at intervals, and in the simple catarrhal cases it is applied into the middle meatus by a saturated cotton swab.

The primary results were 87% of the sinus cases and 85.71% of the catarrhal cases cured or greatly improved. The permanent results (3 to 18 years) showed some relapses. Yet the sinus cases showed 57% cured, and in the catarrhal cases the favorable percentage was 83.3%.

Van de Loo [86] employed a new preparation called Nopenol in 95 cases of severe acute and chronic maxillary sinusitis, with good results. The preparation is penicillin procaine in an oily suspension, 300,000 units per 5 cc. This was instilled into the sinus one to three times before resorting to surgery. A tabulation of the results shows 61 out of 63 acute cases cured, 18 out of 27 chronic cases, and only 2 out of 5 dentogenous cases. Thus only 14 out of the 95 cases failed to respond to the therapy.

Busis and Friedman [87] recommend Biomydrin as an effective therapeutic agent for the treatment of nasal and sinus infections. The proprietary drug is a combination of phenylephrine hydrochloride, thonzylamine hydrochloride, gramicidin, neomycin, and thonzonium bromide. It is used in the form of a spray. In a series of 48 cases where smears and cultures had been taken it was shown that the bacterial flora were markedly reduced or eliminated.

The authors found also that the vasoconstriction was prompt and lasting, without secondary congestion. There were no marked local or systemic reactions. Direct smears revealed a definite decrease in polynuclears and eosinophiles.

CLINICAL—MAXILLARY-FRONTAL

Richter [88] emphasizes the role of inherited predisposition to recurring infections of the sinuses and the development of chronic maxillary sinusitis. He cites Schwarz' [89] work, in which the special structure of the mesenchyma, as revealed in his histologic studies, indicated a constitutional weakness of the mucosa. A special type of infection is the odontogenic, which is generally unilateral but in other respects resembles the usual chronic purulent polypoid type. In some of these cases the pathology was limited to the floor of the antrum, the remainder of the mucosa appearing practically normal. In contrast to the purulent type is the hyperplastic edematous type, which usually involves most of the sinuses and is based primarily on allergic and other consti-

tutional factors and often associated with asthma. The author claims also that the condition may result from a low-grade infection of dental origin persisting over a period of years with few symptoms except recurring headaches and nasal obstruction. Several cases of this sort are cited. However, they are characterized by being chiefly unilateral, recurring frontal and temporal headaches, with discrepancy between the symptoms and local findings. Seldom is the bony floor of the antrum involved. Infection may be carried to the antrum mucosa by way of the periosseous vessels, which have been demonstrated by K. Peter.

According to Hill,[90] headache may usually be discounted as a characteristic symptom of sinusitis. The history of frequent colds, postnasal discharge, nasal obstruction, plus a background of familial tendency toward upper respiratory disorders and allergy, is usually present. X-ray pictures, with or without contrast media, are extremely valuable in the diagnosis. Possible dental foci as well as allergic factors must be sought for and weighed in the balance. Emphasis also must be placed on the general condition of the patient, since many constitutional factors may play a part in the persistence of symptoms. Surgery is therefore not to be undertaken lightly, but when all the other factors have been eliminated it may still be necessary and, when thus indicated, should be radical only when proved absolutely necessary.

Bjork[91] found only 4.6% of 1019 cases of maxillary sinusitis to be of dental origin. The reason the incidence is lower than represented by others is because the latter based their calculations only on cases that were either hospitalized or operated upon. Foul-smelling pus was found most frequently in connection with dentogenous infections, although in bilateral infections the etiology was not in the teeth. On the other hand, a few cases of dentogenous origin did not yield foul pus; these were probably due to a paradental osteitis.

The author found surgery necessary in only 24 out of 60 cases. The others were cured by daily irrigations and instillations of sulfathiozole solution. Most of the cases operated on were complicated by involvement of other sinuses.

His experience with oroantral fistulae included 17 cases; 5 healed before treatment of sinusitis was started, 6 healed during treatment, 1 healed at termination of treatment, 1 healed after simple excision and closure during treatment (fistula of 10 years' duration), 2 healed after closure in connection with a Caldwell-Luc procedure, and 2 required a plastic procedure. He is therefore of the opinion that a fistula in itself is no indication for surgery unless it is exceptionally large.

In the discussion that followed, it was pointed out by several that it was not always necessary to remove the offending tooth, because in many cases the infection spread to the antrum from an apical granuloma. Therefore, in these instances an apical resection would be sufficient and the tooth could be saved. At the same time, of course, the sinusitis should be treated in the usual way.

Bauer[92] reports two cases of recurring erysipelas of the cheek due to chronic maxillary sinusitis. He believes that the condition, though behaving like a true erysipelas, is in reality an allergic-hyperergic reaction in the soft tissues already sensitized to the infection. This belief is based on the fact that the process was not accompanied by the usual reactive phenomena, such as fever, leucocytosis, etc., and failed to respond to antibiotics. Furthermore, eradication by surgery of the chronic infection disclosed in the adjacent antrum resulted in disappearance of the soft-tissue reaction. He cites Hajek, Killian, Weichselbaum, and Denker-Kahler in support of this thesis.

Chisolm[93] discusses the histopathology and general clinical aspects of the Hand-Schüller-Christian syndrome, which in some respects is similar to that of Letterer-Siwe and eosinophilic granuloma. The three

are generally referred to as manifestations of a systemic reticuloendotheliosis. The Letterer-Siwe complex is an acute, rapidly fatal form occurring in infancy or early childhood. Eosinophilic granuloma is a chronic form, usually solitary. Hand-Schüller-Christian's disease is a subacute manifestation of a xanthomatosis, characterized by x-ray defects in the membranous bones, diabetes insipidus, and exophthalmos. Several cases are cited in which the orbit and sinuses were involved. X-ray therapy, plus antibiotics, may result in resolution if the diagnosis is made early enough.

Aubry and Bosdeveix [94] describe an unusual case in which the patient, having had slight frontal headaches for several months, experienced an electric-like shock as he passed his hand across his brow while washing. X-rays revealed a defect in the bone just below the sinus. It was operated upon, and the defect was found to be surrounded by an area of osteitis. The nasofrontal duct was found to be occluded, but the intersinus plate was eroded, as was the posterior wall of the sinus, exposing the dura. The opposite frontal was opened and found to be filled with fungoid masses, and its duct also was blocked. This explains why the patient never had a nasal discharge. The passages were kept open with acrylic and nylon tubes for several months, and subsequent x-rays revealed the sinuses had returned to normal translucency. The etiology was not mentioned.

Moore, Moore, and Brown [95] report four cases of Crouzon's deformity occurring in two brothers and two sisters. The characteristics of this syndrome are cranial deformities, facial malformations, and eye changes, comprising a thickening of the frontal prominence extending down to the nose, thickening of the entire frontal plate (as in osteitis frontalis interna), a high-arched palate, thickening of the facial bones (often constricting the nasal passages), exophthalmos, strabismus, and prognathism.

The etiology is unknown, and the only therapy mentioned was submucous resection of the lateral nasal walls and floor to improve nasal respiration.

CLINICAL—ALLERGY, TRAUMA, MISCELLANEOUS

Unger [96] observed that hay fever patients suffer more at times when the humidity is high. They feel at their best when the fraction formed by temperature over humidity approaches 2 over 1, as for instance, temperature 70 F and humidity 35%. His theory is that hay fever is a phase of chronic sinusitis induced by the climatic humidity, hay fever being seen during the months when heat and humidity are at their highest. He compared findings in a series of 19 cases of hay fever and 13 cases of sinusitis and found the bacterial flora to be the same in the two series. Cultures were taken and autogenous vaccines prepared, which, when combined with suitable local therapy, yielded gratifying results.

According to Hampsey,[97] what was formerly termed catarrhal sinusitis is now recognized as being mostly allergic sinusitis. Generally it is bilateral, whereas infective sinusitis may frequently be unilateral. The well-known symptoms and diagnosis are rehearsed, and emphasis is laid on the relationship between the sinusitis and lower respiratory affections, which has led to the widespread use of the term "sinobronchitis." The author has had satisfactory results in children through the control of inhalant factors, such as feathers, animal danders, and house dust. Periodic injections with a good house-dust extract have also proved of value.

Grove [98] studied a series of 105 patients with vasomotor rhinitis and symptoms of hyperplastic rhinitis to determine the relative importance of allergy and bacterial invasion in the pathogenesis. In 50% of the cases the skin tests were negative, and in those that were positive it was found that sensitivity to foods was comparatively infrequent. (The patients were all adults.) It was determined that in 75% of all the cases infection was the sole cause of the

symptoms. The author discusses most of the therapeutic measures employed and concludes that surgery is definitely indicated in the infective types and will yield good results. In his series of cases that were operated on, 20% showed marked improvement and 73.3% very definite improvement. He believes the surgery should be complete insofar as eradicating the diseased areas is concerned and therefore believes the so-called radical operations, such as exenteration of ethmoids and Caldwell-Luc, should be done. Since allergy was proved to be a factor in 25% of the group, adequate therapy along these lines is indicated. This includes all the accepted procedures for desensitization, symptomatic control, and even the bacterial vaccines in selected cases. It is often important that the otolaryngologist work in conjunction with the allergist in these cases.

Howell [99] reports on the treatment of maxillofacial trauma at an evacuation hospital in Korea. Minimal débridement, careful cleansing, and removal of foreign bodies have been stressed before. However, the use of magnets for the extraction of metallic foreign bodies proved an additional valuable agent. When the maxillary sinus was involved, drainage was effected through a nasoantral window.

Dukes and Lore [100] report an unusual case in which a child of 5 years had fallen, ramming a splinter of wood into his nostril. He was admitted in a comatose condition, bleeding from the nose, and had vomited several times. The splinter, measuring 3 to 3.5 in. in length, was extracted, and the point of entry noted in the region of the anterior end of the inferior turbinate. Meningitis developed, the spinal fluid revealing Diplococcus pneumoniae. Cultures showed it to be a Type 4 Pneumococcus sensitive to oxytetracycline, penicillin, erythromycin, sulfisoxazole (Gantrisin), and streptomycin but resistant to chlortetracycline and chloramphenicol. He was given penicillin, sulfadiazine, sulfisoxazole, and sodium citrate (Citrasulfas, Upjohn). During his 14 days in the hospital he received 146,000,000 units of penicillin, 3 gm. of sulfadiazine sodium, 5 gm. of sodium citrate, and 29 gm. of sulfisoxazole. Subsequently, after the meningeal symptoms had subsided, he was brought in again complaining of pain in the nose. At this time another piece of wood was found protruding from the nostril, which was easily removed. It measured 12 cm. in length. The author claims that failure to see the piece of wood originally may have been a fortunate inadvertence, since early attempts at removal before the infection was controlled might have precipitated graver complications.

Korani [101] adds another case to the growing list of Kartagener's syndrome reported in recent years. X-rays showed the dextracardia, the bronchiectasis, and agenesis of the frontal sinuses. He is inclined to believe that the bronchiectasis is due to a congenital weakness of the bronchial walls with superimposed chronic infection. The author refers to his previous communication on the subject (1952), in which he reported two cases in sisters, both of whom were of small stature with short limbs and small hands and feet.

Another case of Kartagener's syndrome is reported by Katz and his associates.[102] This one was in a 20-year-old youth, with a history of cough and postnasal drip since childhood. X-rays revealed bronchiectasis and dextracardia. The only information on the sinuses that was noted in the report was absence of the frontal sinuses.

Brown [103] cites seven cases of subclinical acromegaly, which he believes was due to toxins of chronic sinusitis affecting the pituitary. The infection may reach the gland by direct extension from the sphenoid, as shown by Pickworth and Graves some years ago, or by way of the blood stream. He believes it is more than a coincidence that all seven cases occurred in persons residing in northern coastal areas. In one patient followed for 16 months separation of the lower incisors was halted after treatment of the sinusitis. Acromegaly should be suspected if the patient notices that shoes and

gloves are getting tight. Examination may reveal a slight indenting of the jaw, with beginning separation of the teeth. These cases should be carefully examined for signs of a chronic sinusitis.

Bazzana [104] is convinced that there is such a thing as a vacuum headache due to negative pressure in a sinus. He quotes Sluder, Hilding, and others. Also, he points to the numerous contributions on the subject of aerotitis or barotrauma affecting the sinuses. In the 18 cases which he summarizes there was evidence of occlusion of the maxillary ostium by disease or some anatomic deformity, in which relief of the headache was obtained either through freeing of the middle meatus or by puncture through the inferior meatus. From the diagnostic point of view, he claims that a trocar passed into the antrum beneath the inferior turbinate, fitted with a manometer, will determine whether there is a normal variation of pressure during the respiratory cycle. Absence of these normal readings will indicate obstruction, and, since the reestablishment of a normal interchange of air is followed by relief from the headaches, this would seem to prove his point.

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Abstracts from Current Literature

Ear

OCCUPATIONAL HEARING LOSS. JOSEPH SATALOFF, Eye, Ear, Nose & Throat Month. **34**:105 (Feb.) 1955.

Occupational, or industrial, deafness is a type of hearing loss following exposure to very loud industrial noises. It usually first involves the higher frequencies. A temporary hearing loss, the so-called auditory fatigue, may be produced by exposure to a specific type of noise. Although permanent hearing loss resulting from noise exposure generally occurs in the higher frequencies before effecting the lower ones, severe temporary hearing loss may be found in the lower frequencies without showing any significant loss in the higher frequencies. Repeated episodes of severe auditory fatigue may occur without any significant permanent hearing loss. Since there is no rigid proof of the relationship between temporary and permanent hearing loss, it is difficult to draw any conclusions as to susceptibility to permanent deafness from the response to auditory fatigue. The characteristic type of hearing loss in industrial deafness is, however, permanent and irreversible.

The characteristic finding in occupational deafness is a difficulty in understanding speech rather than one in hearing speech. Discrimination is impaired by the failure to understand certain speech sounds represented by certain of the consonants. The deafness may be severe enough to interfere with the understanding of speech either during work or away from work.

There is an essential lack of valid scientific data and conclusions relating to noise and deafness. There is an interrelationship of the intensity of the noise and its spectrum, the time relation of the noise, the duration of exposure, and the individual susceptibility to acoustic trauma. It is, therefore, necessary not only to measure the over-all sound level but to study the spectrum of the noise. It is probable that some of the suggested damage-risk curves which correlate intensity and spectrum will prove satisfactory after carful experimental and field studies.

A conservation of hearing program for industry should include routine accurate preemployment audiometry and routine repeated audiograms for employees exposed to intense noise, evaluation of the role of temporary hearing loss among employees, a comprehensive noise survey of the plant, and a determination of the required safety precautions and protective measures. The audiometric examinations must be performed by well-trained personnel using calibrated equipment and a sound-controlled room. The time of day of audiometry is important in that temporary deafness can be excluded or taken into consideration during the final interpretation.

The otologist must acquire a clear perspective of the many facets of occupational deafness. He must distinguish factual opinions from speculative ones and must restrict his opinions to medical problems rather than to the compensation aspects. He must remain critically objective in determining whether a hearing loss is due to acoustic trauma or some other cause.

JENNES, Waterbury, Conn.

OTOLOGIC CONSIDERATIONS OF NOISE IN INDUSTRY. J. W. MCLAURIN, Eye, Ear, Nose & Throat Month. **34**:175 (March) 1955.

The otologic considerations of noise in industry are presented in a very thorough and precise fashion. The subject is covered from various points of view: as a medical problem, as a medicolegal problem, as an industrial hazard, and as a personal problem of the worker who has lost part of his hearing. This article contains much useful detail and should be read in its entirety.

JENNES, Waterbury, Conn.

Pharynx

PHARYNGOESOPHAGEAL DIVERTICULUM AND THE OTOLARYNGOLOGIST. FRANCIS E. LEJEUNE, Ann. Otol. Rhin. & Laryng. **63**:352 (June) 1954.

LeJeune reviews 73 cases of pharyngoesophageal diverticulum occurring during a 10-year period ending Dec. 31, 1953. The average age of the patients in the series was 60.6 years. The

lesion was found somewhat more comonly in men than in women. Of the 73 diverticula, 46 showed deviation to the left, 20 were found in the midline, and in only 7 was the deviation to the right side.

In the entire series, 32 patients were not operated upon because of their refusal of surgical treatment or because they were poor surgical risks due to cardiovascular disease, advanced age, or poor general physical condition. In the remaining 41 patients, one-stage diverticulectomy with general anesthesia was performed. Results were successful in 36 patients. In five patients there were complications in the form of right recurrent nerve paralysis (one case), left recurrent nerve paralysis (one case), external fistula necessitating reoperation (one case), and esophageal stricture necessitating prolonged dilatation (two cases), with ultimate recovery.

In order to prevent the removal of too much pharyngoesophageal mucosa, with resultant stricture, the author advises routine insertion of the esophagoscope into the esophagus at the time of amputation of the diverticulum sac.

Because of excellent training in neck surgery and daily experience with the pharynx, hypopharynx, larynx, esophagus, and cervical anatomy, the otolaryngologist can occupy an enviable position when surgical correction of pharyngoesophageal diverticulum is considered.

STEELE, Kansas City, Kan.

A STUDY OF LYMPHOID TISSUE OF THE NASOPHARYNX. PHILIP E. MELTZER, Ann. Otol. Rhin. & Laryng. **63**:607 (Sept.) 1954.

According to Meltzer, the problem of nasopharyngeal lymphoid tissue resolves itself into two categories: the rhinological and the otological. When nasopharyngeal lymphoid tissue obstructs the nasal airway, subsequent removal usually satisfactorily solves the problem. When the nasopharyngeal mass encroaches on the Eustachian tube simply by contiguity, any interference with tubal function can similarly be corrected by surgical removal of the mass. However, when tubal dysfunction recurs after operation, either following or in the absence of upper respiratory infection, then it is apparent that there must be residual lymphoid tissue either in the fossae of Rosenmüller, within the tubal orifice, on the torus, the salpingopharyngeal bands, or salpingopalatine bands.

Irradiation acts on the secondary nodules of nasopharyngeal lymphoid tissue and manifests itself in three stages: first, cessation of proliferative activity; second, conspicuous scavenger activity, during which the destroyed cells are removed; third, depending on the dosage used, the return of proliferative power. Irradiation by any means—x-ray, radium, or ultraviolet rays—produces the same effect. The author prefers x-ray irradiation.

Surgery has the advantage over irradiation in that it actually removes the mass of lymphoid tissue. Lymphoid regrowth which results in tubal closure is best managed by considering the patient's history and the findings by direct vision at the time of operation. If loss of hearing has followed tubal closure after upper respiratory infections but has returned to normal after a few inflations of the tube, the obstructing lymphoid tissue is removed surgically. If, on the other hand, the tubal occlusion recurs after an upper respiratory infection and inspection of the nasopharyngeal vault shows it to be free of nodules, irradiation is advised. Six hundred roentgens in three treatments (100 r to each side through an intraoral cone or over the lateral neck) is the dose used.

If the patient has recurring tubal closure without upper respiratory infection and lymphoid tissue is noted, the lymphoid tissue is thoroughly removed by surgery and x-ray treatments are started two weeks following surgery. If this fails to produce desired results, allergic studies are started, whether or not the patient shows clinical evidence of allergy.

Where the patient is known to have a history of allergy but has failed to respond to allergic management, the nasopharyngeal lymphoid tissue is removed surgically. If there has been no allergic treatment and the patient shows clinical signs of allergy, then allergic management is instituted first. If there is poor response, surgery is performed. Whether or not irradiation is then given depends on the postoperative course.

STEELE, Kansas City, Kan.

Larynx

TRACHEAL AND BRONCHIAL PAPILLOMATOUS IMPLANT SHOWING MALIGNANT CHANGES. HOWARD MCCART, Ann. Otol. Rhin. & Laryng. **63**:498 (June) 1954.

A case of multiple papillomata of the larynx is reported. During two years prior to the first examination by the author, the patient had received 9000 r by teleradium, without benefit. McCart performed tracheotomy for relief of dyspnea, and for two years papillomata were removed from the larynx with biting forceps. Again dyspnea developed, and bronchoscopy then showed papillomata on the posterior tracheal wall from the level of the tracheostomy to the carina and in the orifice of the left main bronchus. Treatment included forceps removal, chlortetracycline (Aureomycin), and corticotropin (ACTH) during the next year. It was then found that malignant changes had taken place in some of the papillomata removed from the tracheobronchial tree. During the next three years, numerous bronchoscopic forceps removals of papillomata were done until the patient died at the age of 16 years of massive pulmonary hemorrhage. No autopsy was obtained.

STEELE, Kansas City, Kan.

INJURIES OF THE RECURRENT LARYNGEAL NERVES DURING THYROID OPERATIONS. GERALDINE M. BARRY, Proc. Roy. Soc. Med. **48**:437 (June) 1955.

Mr. Barry is Senior Surgeon to the Royal Free Hospital, London. The Section on Surgery is under the presidency of Harold C. Edwards, C.B.E., M.S., F.R.C.S. The meeting was on Feb. 2, 1955. Most of the cases seen were nodular goiters with pressure symptoms or a secondary thyrotoxicosis. In performing thyroidectomies, some surgeons dissect out and identify the nerve, which is probably the common practice in the U. S. Others "follow Joll's [Mr. C. A.] method of not dissecting out the nerve deliberately," but identifying it through the fascia by palpation. The thought is that more damage may be done by dissection because of hemorrage and ultimate fibrosis. Mr. Barry reviews the anatomy of the neck, especially the layers and extensions of the fascia. Relation of the recurrent laryngeal nerves to the tracheoesophageal groove and lateral ligament is discussed, and the point is emphasized that the one constant relationship of the recurrent and its branches is its point of entry into the larynx behind the inferior cornu of the thyroid cartilage at or just above the lower border of the inferior constrictors of the pharynx. There is also the matter of the penetration of the thyroid gland itself by the recurrent laryngeal, but this appearance may be simulated rather than actual. It was rarely penetrated in Mr. Barry's experience: something like 38 times for both right and left nerves in 1991 cases. A further point is the relation of the recurrent nerves to the inferior thyroid vessels. The middle and inferior thyroid veins lay on a plane anterior to the nerve. The nerve lies posterior to the artery in the greater number of instances. An aberrant nerve is commoner on the right. Branching of both nerves to the trachea and esophagus as well as to the larynx may be expected. There is, to be sure, aberrance of the laryngeal nerve in relation to the right subclavian artery. "The nerve may be anterior or posterior to the inferior thyroid artery."

In the discussion, under anatomical considerations alone, it was concluded that there is a small but irreducible and inherent risk of damage to the recurrent laryngeal nerves in thyroidectomy.

ABSTRACTOR'S COMMENT: Partial paralysis of the vocal cords, usually the left, following thyroidectomy is a surgical hazard which every surgeon will try his best to avoid for personal, medicolegal, and every other human consideration. By dissecting the nerve out freely (and this is not usually very difficult to do), one knows exactly where it is, and makes sure that it is not going to be severed. Such vocal changes as ensue after the wound heals are usually of limited extent and duration and are mainly due to "manhandling" as a necessary part of any other operation. Most such cases recover completely with time and management. But if the nerve has been severed, there will be no voice recovery unless and until an operation can be done to join the severed ends. This is an old story and scarcely needs mention here.

I. W. VOORHEES, New York.

Nose

THE TERM "RHINOPLASTY." IRVING B. GOLDMAN, Eye, Ear, Nose & Throat Month. **34**:258 (April) 1955.

The term "rhinoplasty" is derived from the Greek: rhis (nose) and plassein (to form). A change in the form of the nose or any component part constitutes a rhinoplasty. This may be

restorative, corrective, cosmetic, complete, or incomplete. As Adams has pointed out, considerable confusion has existed in nomenclature as plastic surgery has developed. Surgeons in different localities use different terms, and a single operation may be called by a variety of names. Nomenclature should be standardized in order that surgeons can compare statistics and results.

There is an objection to the use of the word "rhinoplasty" in some parts of the country. In some hospitals other terms must be substituted for rhinoplasty in the operative descriptions. These include nasoplasty, nasoseptopexy, reconstruction of the nose, and reconstruction of the nasal pyramid. In the early development of rhinoplasty, much of this surgery was performed by quacks, who advertised in newspapers, magazines, and telephone books, and the word "rhinoplasty," therefore, developed unholy connotations and, at the very least, lacked professional dignity. In addition, many of the so-called plastic surgeons had poor surgical backgrounds. In the past two decades, however, nasal plastic surgery has made great progress and there has been an increasing recognition of its psychologic, physiologic, and esthetic significance. With the entrance of many otolaryngologists into this field, rhinoplastic techniques and results have improved. Consequently, more persons, not only in large cities but also in less-populated areas, have submitted to the operative procedures.

The term "rhinoplasty" should, therefore, be used today without verbal camouflage. It has taken on a dignified and well-merited status. This is demonstrated by the increasing number of articles on rhinoplasty appearing in the scientific journals and on the programs of the medical societies.

JENNES, Waterbury, Conn.

THE CHISEL OR SAW IN RHINOPLASTY? IRVING B. GOLDMAN, Eye, Ear, Nose & Throat Month. **34**:330 (May) and 396 (June) 1955.

The chisel was utilized early in the development of rhinoplasty because most of the procedures were performed through external incisions which required the use of the chisel. When Joseph developed the complete intranasal technique for rhinoplasty, he introduced the use of the saws for the removal of a bony hump and for the lateral osteotomy. Sheehan preferred the chisel to the saw, as he felt that this allowed maximum control and left little or no bone detritus which might cause osteogenesis. Another technique utilizing the chisel included use of the rasp after removal of the hump, in which case bone detritus would obviously be present. Goldman is of the opinion that the residual irregularities of the dorsum are due not to osteogenic remnants following use of the saw but rather to particles of the procerus muscle frayed during elevation from the nasal bones. This has been proved by the findings in revisions of operations on patients who presented these irregularities.

A disadvantage of the use of the chisel in the removal of a bony hump is that once the chisel has become engaged it must proceed in the same direction and cannot be altered, whereas with the saw the surgeon can easily place it at the proper level. In either case, following hump removal, the edges are smoothed with a fine rasp and the remnants of bone spicules and frayed remnants of muscle are removed with a Lewis rasp. Safien believes that the removal of a bony hump with a saw is the proper method because the saw is easily guided on a definite plane and permits exact removal. If the hump is removed by a chisel, a smooth even surface is rarely produced. The original technique for removal of the hump is described in detail in Joseph's own words.

The bayonet saw used for removal of the hump may be held in one of two positions: either with shank higher than the level of the blade or in reverse fashion. Goldman favors the position in which the handle of the saw is in a superior planes because he feels there is a tendency for removal of a larger hump than contemplated when the saw is inserted with the handle on the lower level.

The proper technique for the use of the angular saw in performing the lateral osteotomy is described in detail. It is essential that the tip of the saw work first through the thick bone of the glabellar area and then gradually saw through the lower and thinner portions. Another practical point is that the saw should go through almost the entire thickness of the bone and not through a part of it. Fracturing of the nasal processes is simplified if these two points of technique are followed. External osteotomy is not only unnecessary but may cause permanent visible scars and keloids.

It is frequently a lack of dexterity in the use of the saw which prompts use of the chisel. Expert instruction in the correct technique of the use of the saw is essential. Among the dis-

advantages in the use of the chisel for the lateral osteotomy may be included external perforations, a change in direction of the chisel as it proceeds toward the frontal area, an unexpected bony fracture, and the occasional fragility of the chisel, resulting in a fracture of the chisel. The latter may take place when a chisel is used as a lever to outfracture the bones. To guard against this mishap, it is important that if there is the slightest impact of the chisel when operating the intrument should be carefully withdrawn, reintroduced, and the outfracture performed without force. It is occasionally very difficult to recover the broken fragment of a chisel. Goldman does not favor outfracturing, which he feels often leaves a wide nasal bridge, probably due to soft tissue intervening in the gaps between the bones, The chisel is invaluable when it is necessary to break the spring of the radix or to improve the nasofrontal angle or for removal of wedges to narrow the radix or to remove the anterior nasal spine.

Although Goldman feels that the proper use of the saw in rhinoplasty yields ample compensation in that it is more accurate and less hazardous than the chisel, he closes his paper with the statement that all this is in no way derogatory to those who find the chisel adequate because, quoting Pick, "The ability and imagination of the operator are far more important than the type of instrument used."

JENNES, Waterbury, Conn.

Miscellaneous

A PROSTHETIC DEVICE FOR FACIAL RHITIDOSIS. ADOLPH M. BROWN, Eye, Ear, Nose & Throat Month. **34**:182 (March) 1955.

A device is presented which eliminates facial wrinkles. This prosthetic device can be applied and removed by the patient and is easily concealed in women's hair. It achieves results comparable to a surgical face lift by applying traction to the sagging facial skin.

JENNES, Waterbury, Conn.

CHANGING CONCEPTS IN OTOLARYNGOLOGY (EDITORIAL). Eye, Ear, Nose & Throat Month. **34**:323 (May) 1955.

Otolaryngology has become a broader and a sounder specialty. The scope of the otolaryngologist is as broad as his training has provided. Endaural, maxillofacial, and head and neck surgery, endoscopy, and rhinoplasty embrace a large area of clinical endeavor. The specialist in otolaryngology should have a good background in general medicine and surgery. He must be familiar with accepted diagnostic methods and must be able to interpret roentgen films and the results of laboratory tests. The program is a varied one with as much emphasis on the nonsurgical as on the surgical branches. It is only important that a favorable end-result be obtained, whether the method be surgical or nonsurgical. The otolaryngologist must be familiar with rehabilitation of the hard of hearing and give proper attention to the diagnosis and treatment of allergic diseases.

The future of otolaryngology holds out unlimited potentialities of further progress. Research in the basic sciences related to or associated with otolaryngologic diseases has led to an improved understanding of their underlying problems, with the emphasis on constructive therapy.

JENNES, Waterbury, Conn.

CYSTS OF THE FACE. A. M. MAMLET, Eye, Ear, Nose & Throat Month. **34**:388 (June) 1955.

The pyriform osteotomy incision utilized in rhinoplasty offers a good approach to the removal of cysts of the face. Mamlet has used this approach for the removal of facial cysts in eight patients. This avoids an external incision and the possibility of leaving a scar. The normal contour of the face is promptly restored because there is no trauma to the skin. The surgical technique is described in detail.

JENNES, Waterbury, Conn.

A SURGICAL PROCEDURE FOR THE RELIEF OF SNORING. C. J. HEINBERG, Eye, Ear, Nose & Throat Month. **34**:389 (June) 1955.

The Schwartz operation for relief of snoring by removal of a portion of the isthmus of th soft palate and a portion of the uvula, if elongated, in order to tense the soft palate has been modified by the substitution of a simpler procedure. The rationale is based on the observation by Schwartz that snoring was frequently relieved following tonsillectomy when the posterior

pillar was inadvertently removed. This caused the soft palate to become tense, reducing its ability to vibrate and to reach the posterior wall of the pharynx. Since snoring is a result of vibratory actions of the soft palate against the posterior pharyngeal wall, this tensing of the soft palate will tend to obviate snoring. Schwartz then devised an operation to tense the soft palate by removing a portion of the isthmus and a portion of the uvula, if elongated.

Heinberg has devised a simpler procedure to tense the soft palate. This consists of a triangular incision made on each side of the uvula, with the apex toward the hard palate and the base of the triangle at the rim of the isthmus, of sufficient size to cause tension. The underlying muscles are divided and resected. The uvula, if elongated, is corrected by partial resection.

JENNES, Waterbury, Conn.

GLOBUS. MEADE MOHUN, Laryngoscope **65**:73 (Feb.) 1955.

Globus has been described as being a hysterical condition, and it is true that the great majority of patients with such symptoms have no organic basis for them. However, there are organic causes. Some mentioned by Mohun include (1) areas of anesthesia left after an acute throat infection, (2) persistence of feeling of a foreign body after it has been dislodged, (3) hyperplasia of lymphoid tissue, (4) atrophic changes, (5) webs at the entrance of the esophagus, (6) elongated uvula, (7) tumors, cysts, etc. Many other organic lesions are listed which may cause symptoms of globus.

What do we do for the patient without one of the above organic causes? Simple reassurance is often not enough. These patients are frequently under stress difficult for them to bear. This may have to do with the hypothalamus, which transmits central autonomic impulses to the body. When the hypothalamus cannot cope with certain stimuli, an acute or chronic disturbance of some end-organ may result. It may be in the nose, ear, head, or throat. There may be an end-artery or muscle spasm. If the disturbance is in the throat, the sensation of globus will result.

The Rauwiloid drug Serpasil acts in relieving anxiety tension and has proved very efficacious. In 30 cases so treated, 19 showed from marked improvement to complete cure and most have a greatly improved general outlook.

HITSCHLER, Philadelphia.

TREATMENT OF ORAL CANCER. ROBERT M. BOGDASARIAN, New York J. Med. **55**:2213 (Aug. 1) 1955.

This is the fifth article in a series on the treatment of cancer, under the editorship of Irwin E. Siris, M.D. The author lives and works in Binghamton, N. Y., and the entire project is under the New York State Department of Health. A general history of the patient and his surroundings is imperative in each instance. We must know the site of the lesion (whether anterior or posterior, on the tongue, gums, cheeks, palate, tonsil, or floor of mouth), its histopathology, the patient's blood picture, and what cosmetic result may adversely affect the patient's ego. Both the mental and physical set-up of the case at hand should be evaluated. A dentist or oral surgeon will extract teeth which may be in the way of radiation, put the mouth in good hygienic condition. Indeed, the dentist should be an active participant before, during, and after surgery. When radium or massive x-ray dosage is used, one must have in mind the possibility of radio-osteonecrosis. If radiation precedes surgery, healing may be slow, with partial healing only; then tissue breakdown with infection is prone to occur. Some 90% of oral cancers are squamous in origin and nature. In general, anteriorly placed lesions are less active and are more manageable than posterior ones. Lip cancers usually grow slowly and do not metastasize immediately. Radiation is useful in poor-risk and advanced cases generally. Excision of the tongue and jaw and massive gland dissection in the neck are formidable in any case. Dental prostheses must wait for a long time so that they will be tolerated when the tissues are ready for them.

I. W. VOORHEES, New York.

Books

Advances in Otolaryngology. Volume II. By L. Ruedi, M.D.; co-contributors: F. Altman and K. Graf. Price, 36 Swiss francs. Pp. 274, with 40 illustrations. S. Karger, Holbeinstrasse 22, Basel, 1955.

This second volume closely follows the principles of Volume I in that consideration has been given to the most recent thoughts, both from the diagnostic and therapeutic viewpoints, on problems that are faced by the otolaryngologist. Essentially three subjects are discussed: Ménière's symptom complex, inflammation and degenerative diseases of the peripheral cochlear and vestibular neurons, and, lastly, tumors of the cerebellopontine angle. Each subject is thoroughly reviewed and contains an extensive bibliography which bears directly upon the subject matter discussed. Each controversial issue is evaluated, and all deductions are crystallized so that the underlying pathologic condition, with its therapeutic potentialities, can easily be correlated.

Ménière's disease is discussed from the standpoint of symptomatology and pathology. Under the latter, the problem of variation of endolymphatic pressure and its influence on both vertigo and deafness is thoroughly evaluated. The authors also discuss the more recent theory of Lempert that there is a chronic progressive herpetic neuritis of the vestibular labyrinth. This may be either toxic or trophic. These herpetic eruptions may rupture and the toxic content exercise its influences upon the endolymphatic system.

Under therapy conservative and radical procedures are discussed. These include electrolyte alterations, which are exemplified by salt-free diets, ammonium chloride and potassium chloride administration, and both dietary and fluid-balance considerations, secondly, histamine and nicotinic-acid therapy. Other measures, such as magnesium sulfate intravenously, papaverine, neostigmine, epinephrine, etc., are mentioned and suggested in difficult cases. Psychic phenomena and moderate sedation are also included, as are suggestions for measures to affect the autonomic ganglion by the various drugs and even superior ganglion or stellate block. Many of the antihistamines and dimenhydrinate (Dramamine) are suggested.

Among operative procedures they mention the tympanic plexis avulsion, the decompression of the perilymphatic space, complete destruction of the labyrinth, and other surgical measures, including the cutting of the vestibular nerve and the surgical attack on the sympathetic nervous system.

The second section is devoted to the influences on the cochlear and vestibular neurons by various drugs, such as quinine, the salicylates, streptomycin, neomycin, tobacco, alcohol, and the various vitamins. Clinical observations are discussed and evaluated.

The third section deals with the pathogenesis of the cerebellopontine-angle tumors, on which numerous case reports have been included with their end-results.

Volume II certainly keeps one abreast of the progress and the present-day evaluation of the various problems that are involved in these three pathologic entities.

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society
(Société Canadienne d'Otolaryngologie)

President: Dr. D. S. Gorrell, 110 Medical Arts Building, Calgary, Alta.

Secretary: Dr. G. Arnold Henry, 328 Medical Arts Building, Toronto.

Place: Chateau Frontenac, Quebec, Canada. Time: June 6-7, 1956.

International Bronchoesophagological Society

President: Dr. Antonio da Costa Quinta, Lisbon, Portugal.

Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.

Meeting: Fourth International Congress of Bronchoesophagology.

President of Congress: Dr. Antonio Carrascosa.

International Congress of Audiology

Place: Leyden, Netherlands.

General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

International Course in Paedo-Audiology

Place: Groningen, Netherlands.

General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. Juan Manuel Tato, Azcuenaga 235, Buenos Aires, Argentina.

Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.

Meeting: Fifth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.

Place: San Juan, Puerto Rico. Time: April 8-12, 1956.

President of Congress: Dr. Juan H. Font, Medical Arts Building, San Juan.

Sixth International Congress of Otolaryngology.

President: Dr. Arthur W. Proetz, 3720 Washington Blvd., St. Louis.

General Secretary: Dr. Paul H. Holinger, 700 N. Michigan Ave., Chicago 11.

Place: Hotel Statler, Washington, D. C. Time: May 5-10, 1957.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. John R. Lindsay, Chicago.

Secretary: Dr. Hugh A. Kuhn, 112 Rimbach St., Hammond, Ind.

Place: Chicago. Time: 11-15, 1956.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Algernon B. Reese, 73 E. 71st St., New York 21.

Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave., Bldg., Rochester, Minn.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

American Board of Otolaryngology

President: Dr. Frederick T. Hill, Professional Building, Waterville, Maine.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Place: Sheraton-Mount Royal Hotel, Montreal, Canada. Time: May 6-11, 1956.

American Broncho-Esophagological Association

President: Dr. Daniel S. Cunning, 115 E. 65th St., New York 21.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3.
Place: Sheraton-Mount Royal Hotel, Montreal, Canada. Time: May 15-16, 1956 (afternoons only).

American Laryngological Association

President: Dr. Bernard J. McMahon, 8230 Forsyth Blvd., Clayton 24, Mo.
Secretary: Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3.
Place: Seigniory Club, Montreal, Canada. Time: May 13-14, 1956.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Dean M. Lierle, Iowa City.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Sheraton-Mount Royal Hotel, Montreal, Canada. Time: May 15-17, 1956 (mornings only).

SECTIONS:

Eastern.—Chairman: Dr. John A. Murtagh, Hanover, N. H.
Place: The Statler Hotel, Boston. Time: Jan. 13, 1956.

Southern.—Chairman: Dr. J. M. Robison, Houston, Texas.
Place: The Shamrock, Houston, Texas. Time: Jan. 27-28, 1956.

Middle.—Chairman: Dr. William H. Craddock, Cincinnati.
Place: The Netherlands Plaza, Cincinnati. Time: Jan. 16, 1956.

Western.—Chairman: Dr. David D. De Weese, Portland, Ore.
Place: County Medical Society Building, San Francisco. Time: Jan. 21, 1956.

American Otological Society, Inc.

President: Dr. William J. McNally, 1509 Sherbrooke St. West, Montreal 25, Canada.
Secretary-Treasurer: Dr. Lawrence R. Boies, 90 S. Ninth St., Minneapolis 2.
Place: Seigniory Club, Montreal, Canada. Time: May 11-12, 1956.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Joseph Gilbert.
Secretary: Dr. Louis Joel Feit, 66 Park Ave., New York 16.

American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. F. Lambert McGannon, 14595 Madison Ave., Lakewood, Ohio.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2.

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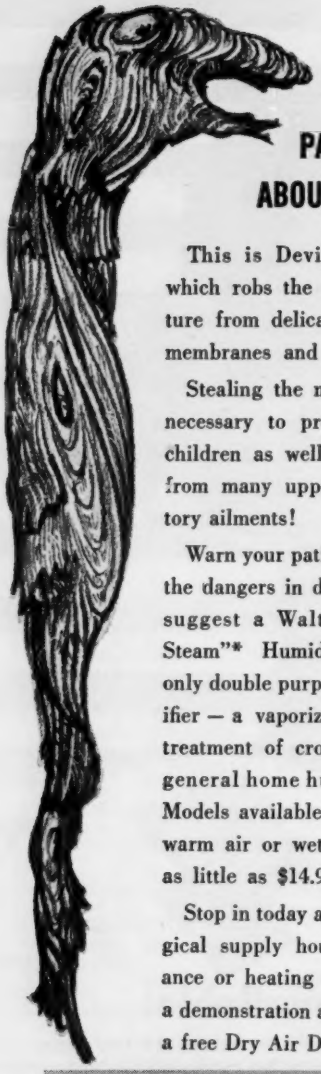

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* See page 662 AMA Archives of Otolaryngology, June 1955. For other instruments designed by Dr. Benito B. Rish refer to:
AMA Archives of Otolaryngology
February 1953, Vol. 57, pp. 206-209
October 1954, Vol. 60, pp. 508-509

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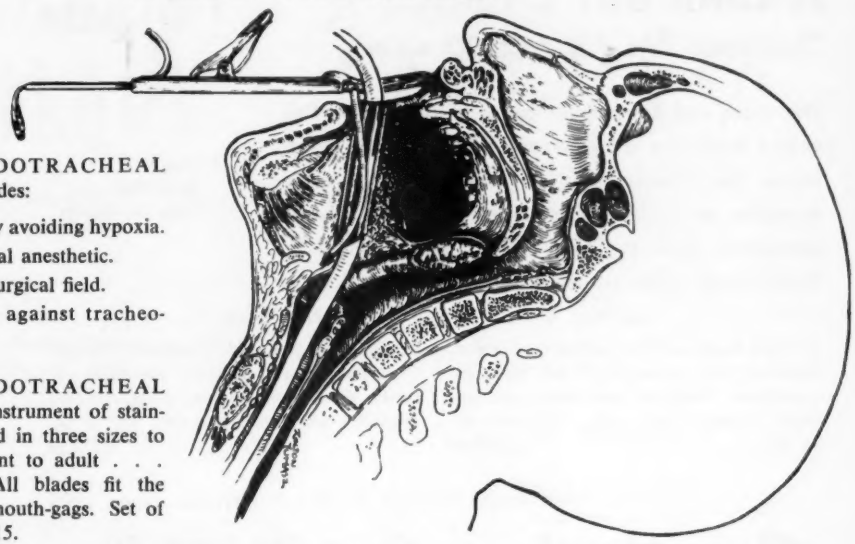

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*Barton, R. T.: Instrument for endotracheal anesthesia during oro-pharyngeal surgery. J. A. M. A. 153:1017 (Nov. 14) 1953.

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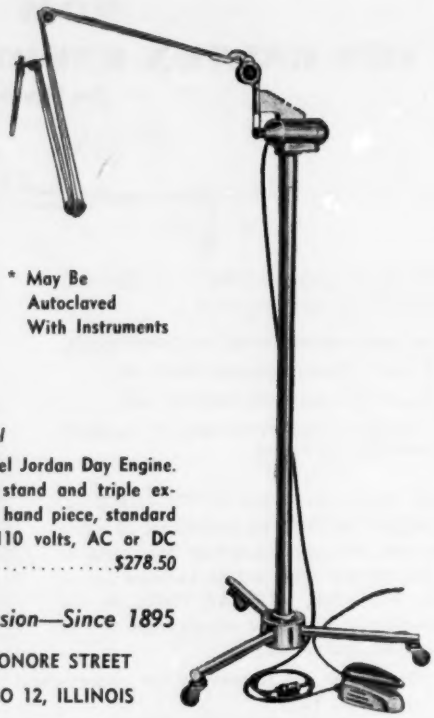

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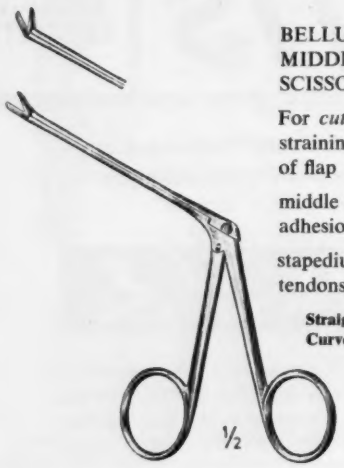

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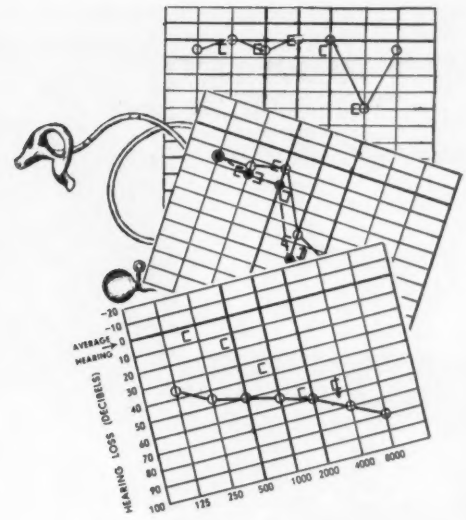

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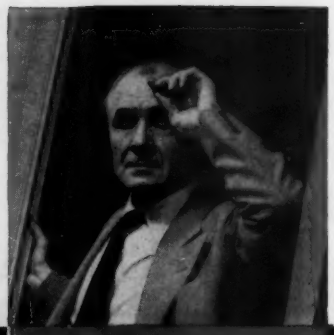

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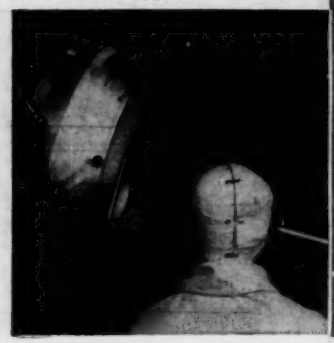

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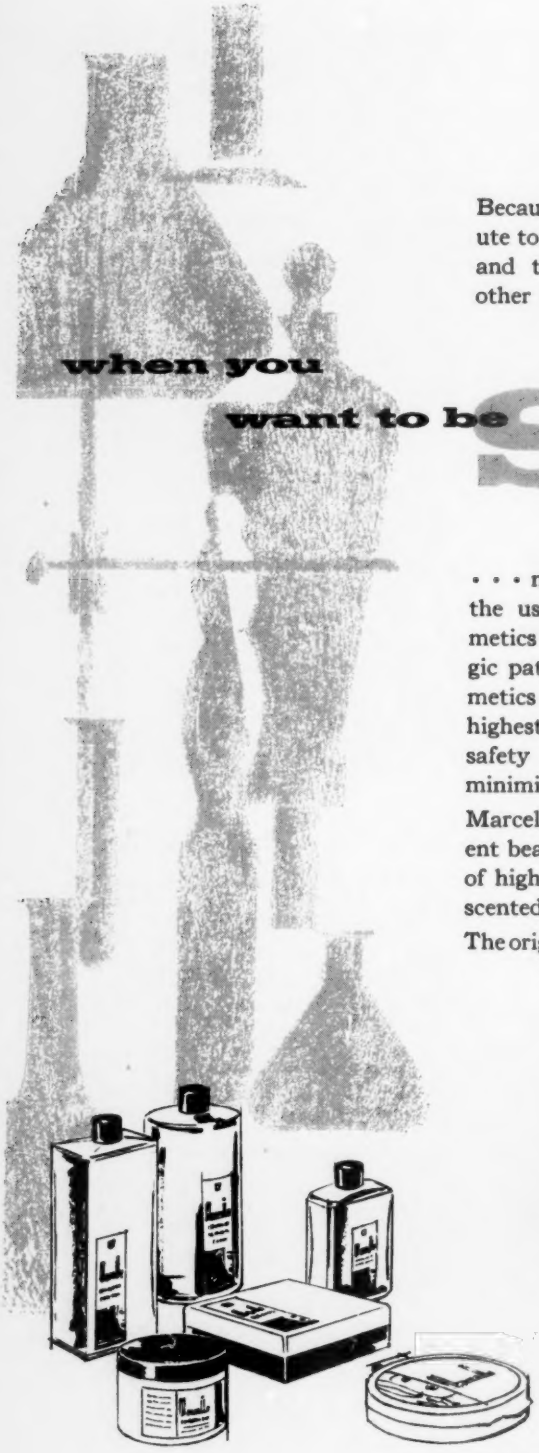

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